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Catskill Water Reaches New York

ALTHOUGH admitted merely for the purposes of testing, Catskill aqueduct water entered into the distribution mains of New York City for the first time about a week ago. This does not mean that the $175,000,000 additional water supply project for the first installment of 250,000,000 gal. daily is finished, and ready for service. J. Waldo Smith, chief engineer of the Board of Water Supply, explained at the convention of the New England Waterworks Association last September that practically all of the year 1916 will be devoted to "tuning up" the great system before attempting to make regular delivery of the flow impounded by the Ashokan dam 100 miles north of City Hall. The event is not without significance, however, for it indicates that the first note in this tuning-up process has been sounded. It means that the great waterway is open from the foothills of the Catskills to Manhattan and Brooklyn. Large quantities of water are already stored in both the Ashokan and Kensico reservoirs; and the Hill View reservoir or equalizing basin, serving as a feeder to the city aqueduct distribution tunnel, began to fill on Nov. 30. The city aqueduct tunnel is under pressure as far as the shaft near Ninety-third Street, and tests of the connections with the distribution mains in the city streets are in progress. It is not possible, however, to predict when the great waterworks system will be placed in regular service. Many finishing touches are still needed, and the Board of Water Supply will take every precaution to insure the proper co-ordination of the many parts of the complex machine before announcing that it is ready for actual use.

Crystallization Doubtful

PROBABLY few, if any, structural engineers who have studied the behavior of steel under stress will accept without criticism the report made by an investigating board on the cause of the Division Street bridge failure in Spokane. As noted on page 29 of last week's issue, these engineers place the responsibility upon the "granulation" of the eyebars. The idea of progressive crystallization under service, accompanied by growing weakness and final failure, is an old one, probably caused through the observation of fractures which, for one cause or another, have been sudden and not accompanied by elongation. Such fractures will appear crystalline instead of silky mainly because the fibers are not elongated and drawn close together, as is the case in the usual laboratory test with gradually applied load. The explanation offered by Mr. Cooper, the designer, seems much more credible, as the effects of bending and heating upon the crystalline structure and strength are easily understood. The results of further investigation will be awaited with interest. In the meantime, the lesson forced home by this catastrophe, apparently caused by a striking failure in such usually reliable members as eyebars in direct tension, is the danger of allowing shop manipulations and heating without subsequent annealing.

New York's Building Code

AFTER three previous attempts at a revision of the building code of New York City had failed and years of effort to remove many obsolete and unsatisfactory provisions had been defeated, largely through the opposition of manufacturers of building materials, a complete and thorough overhauling and recasting of the code has been finally accomplished. This highly satisfactory result is directly due to the ability of the code committee's engineer, Rudolph P. Miller, in harmonizing conflicting interests and demonstrating the possibilities of compromise. The committee is to be congratulated on having selected an engineer whose qualifications so eminently fitted him for this work. While an effective method of procedure was adopted, i. e., revision, article by article, after tentative drafts had been published, suggestions had been received and a public hearing held, the work could not have been done had not a man been selected in whom conflicting interests had absolute confidence. Of Mr. Miller's ability and integrity there could be no question. While the work of revision is complete, only two articles—one on unsafe buildings and the other on the enforcement of the law—have become effective; the others become operative three months after enactment, the last one on March 14, 1916.

Shear Cracks or Tension Failure?

THE reason given for the cracks found in the webs of a large number of I-beam track stringers in the State Street bascule bridge in Chicago, described in the article by F. H. Avery on page 14 of last week's issue, is not wholly convincing. These webs are designated as badly "shear-cracked." Examination of the nature of the breaks shows that the cracks begin at the corner of the coped part near the top flange, as would be expected, and then curve downward toward the lower flange at about a 45-deg. angle. This slope is just opposite in direction to that which would result from a diagonal tension failure due to shear. Further, a rough computation of the probable unit stress in the web, including 90 per cent impact, shows a unit stress not exceeding about 8000 lb. per square inch under the 32-ton cars actually in use. Another explanation of this kind of failure is the presence of negative bending moment near the ends due to the relatively stiff end connection, and the resulting tensile stress in the upper flange, which would tend to start the crack at the weak section just where the metal is injured at the coped corner. Without having examined the beams it is difficult to judge how far the failure may be due to corrosion of the webs, but the evidence from the photograph and the apparently low shear stress certainly raise the question, whether shear was the primary cause of these failures.

Engineer on Service Commission

THE appointment of Henry W. Hodge as a member of the Public Service Commission of the First District of New York marks the successful issue of efforts made for many years in New York State to secure the appointment of an engineer to the important service commission having supervision of the utilities in New York City. In the forefront of this movement has been the American Institute of Consulting Engineers, which has appeared before successive governors, urging the benefit to the public from having a technical man on the commission. It is patent, of course, that the appointment of any engineer whatsoever might not have given satisfaction. An engineer of narrow views and training, of little experience in business affairs, would have been of no advantage to the public or to the profession. Mr. Hodge's appointment, however, is fortunate. An engineer of eminent attainments, a gentleman of broad sympathy and gifted with business acumen, he will shed luster on the office, serve the public ably and help to establish the engineer's position as an important factor in the administration of large public affairs. A few weeks ago the New York press was loud in its praise of the appointment of Oscar Straus as chairman of the same commission. While Mr. Straus is a gentleman above suspicion, there is little in his experience to recommend him for membership on a public-service commission. No man could give more than he will give within the limits of his experience and his ability, and no one will carry out with loftier motives the allotted duties. Nevertheless, there was needed for the position something more than integrity and general experience—specific acquaintance with the engineering and economic problems involved. This specific acquaintance Mr. Hodge has. The commission, the public and the profession will benefit by his appointment.

Shore Protection

BECAUSE the United States is blessed with thousands of miles of ocean front, to much of which little present value is attached, and because the inroads of the sea are usually gradual, and not overnight, as is the case with inland rivers that suddenly break bounds and engulf whole communities, scientific protection of beaches has been even more backward than other flood protection and prevention measures and is, in fact, in its infancy. Individuals and communities have for a long time, it is true, resorted to makeshift devices, such as bulkheads, to withstand the waves, and breakwaters have been built to protect harbors. The breakwater, however, can hardly be considered a feasible or suitable protection for long open beaches, and the futility of the random bulkhead has been repeatedly shown by the coastal storms of recent years. Indeed, the report to which this note would direct attention lists bulkheads themselves as one of the causes, under certain conditions, of damage to beaches. The report in question is that of Messrs. Leeds & Barnard on the situation at Venice, Cal.; an abstract of it appears on page 51 of this issue. While these engineers feature three types of sea walls and a form of groin that they deem especially suited to the needs of Venice—designs that should of themselves interest all concerned in beach protection—they also discuss the general subjects of erosion and sand accretion, and the best means of preventing the one and utilizing the other. The entire abstract should be read by all interested in the "war against the waves," and by others, too, who have not realized the importance and engineering possibilities of coast protection.

Instantaneous Reproduction

SPACE was not available last week for editorial comment on the choice logic of the Minnesota Railroad and Warehouse Commission on reproduction cost, a bit of which appeared on page 12. More of this logic can be found in the brief filed by this commission with the Interstate Commerce Commission in answer to the argument submitted to the national body Sept. 1, 1915, by the railroads. Once more it has been discovered that the Minnesota rate decision puts out of the running all reproduction cost as the railroads interpret it, on the ground that "the assumption of its (the railroad's) non-existence, and at the same time that the values that rest upon it remain unchanged, is impossible and cannot be entertained." Of course the Minnesota commissioners conveniently overlook the fact that Justice Hughes was discussing land only, and make him put the curse on almost the whole reproduction theory, with its assumed legal expenses, its conjectural time of construction and rate of interest, its imaginary contingencies. The Minnesota magicians, however, have rescued the theory by the simple process of *instantaneous* reproduction. By this means all assumptions are eliminated. The landowners, the steel mills, the equipment builders, the contractors, name their prices, are immediately paid in full and the railroad is finished. Of course there has been no time for interest or contingencies. Nothing counts except the actual visible material and the labor of placing it. Absurdities seem never to end in valuation discussion.

Another Plot Exposed

THE Minnesota guardians of the public have also exposed another plot of the soulless corporations to delude the trusting federal authorities. To show the loss the railroads would incur if the values of their perfectly serviceable crossties were written off in part in accordance with their various ages, the carriers used an average of 3000 ties per mile. The Minnesota detectives point out, however, that 2916 per mile would be a liberal allowance. Evidently to them the confiscation of $486,000,000 seems a totally different matter from the confiscation of $500,000,000. But that is not all. The Minnesota statesmen find that the railroads in Minnesota are paying on the average only 62 cents per tie instead of the $1 claimed by the railroads (railroads paying $1.40 apiece for creosoted ties please take notice), and that in 1890 they were paying only 36 cents, so that they are now 24 cents—the commission's arithmetic, not ours—ahead. The fact that these 36-cent ties are several generations removed from those now in the track is deemed to be immaterial, for the reason that the successive advances in the prices of these ties have been charged to operating expenses. Consequently, by overlooking the railroads that have been built recently at nearly 62 cents per tie, the Minnesota mathematicians are able to show that the railroads, instead of losing $500,000,000 by the writing off of accrued depreciation of ties, are still making $13,156,992 over original cost.

The Truth of the Matter

THIS BALDERDASH about ties and that relating to instantaneous reproduction could be treated as light comedy and quickly forgotten if it were not the official utterance of a sovereign state, apparently typical of the amazingly unfair attitude of the commissions of many states. The railroads have been accused of ignoring equity in their attempts to drag in any item that will swell the total, but certainly their efforts are less reprehensible than those of state commissioners who are frantically striving to keep reproduction cost down to original cost by mere technicalities. As conjecture, instantaneous reproduction outdoes the wildest fancies of the railroads concerning multipliers, contingencies and the like. The attempt to warp the Minnesota rate decision into a defense of such a theory is an insult to public intelligence. The Minnesota gentlemen and those of their type should understand that all the laws and all the courts cannot make reproduction cost anything else than what it would actually cost to reproduce, and the Engineering Record has full confidence that just as soon as the Supreme Court is accurately shown what it would cost to reproduce property all doubt on this point will be removed. And in the matter of the ties there is no justice whatever in a proposal that depends on the fact that prices have happened to go up, so that although half of the plant is wiped out the remainder, measured in terms of what it would cost now to replace it, keeps the value up to the original figure. It is patent that if ties had gone down in price instead of up, the Minnesota commissioners would have devised some other technical argument for making the railroads stand the loss. The commissioners, who accuse the carriers of confusing cost and value, are doing the same. They are desperately afraid that proper reproduction cost will fully justify a value ample to warrant increased rates, and they seem to be capable of any subterfuge to prevent those increases.

Summing Up a City's Work

A CLEAR, concise résumé of a large city's activities from those outside the official family is valuable, provided it be prepared from a sympathetic and constructive point of view. Such a review is found in a 16-page pamphlet issued by the Cincinnati Bureau of Municipal Research. The review is the work of an engineer, the director in charge, H. S. Morse, and shows in how small a space six years of activity of a city of 400,000 can be briefed, still leaving room for one and a half pages of retrospect and double that amount for a "look ahead." The engineers' direct way of going to the point is exemplified in some of the admonitions of the pamphlet. For example, Mr. Morse says, "A new reputation as the best governed city in the country, based on facts, calls for work, nothing less." And again, "Caution and inaction are by no means synonymous, and caution and openmindedness can well travel the same road with good results. . . . What we need for civic progress is work—hard work, thoughtful work and, above all, team work." In this month of getting matters in shape for annual reports, a perusal of this little pamphlet is worth while as a suggestion of what should be sent out to the citizens, as distinguished from the statistical data and technical discussions which should go into the appendices of the more bulky document.

Science and Engineering

DR. BRASHEAR'S presidential address last month before the American Society of Mechanical Engineers on the relation of science to engineering, is an interesting exposition of the relations which exist between the scientist and the engineer. Dr. Brashear is both, and the same is true of most really great men in these branches. In fact the difference between the two turns more on a psychological than on a genuinely rigid distinction. If one may venture to discriminate, the scientist is a seeker after truth, the engineer a seeker after the practical applications of truth, whether ascertained by himself or somebody else. The engineer who tries to dodge the rigid implications of science is extremely likely sooner or later to get himself into serious difficulties. The scientist, on the other hand, needs occasionally to pin down his truth to the earth by practical applications, lest he wander so far into the cosmos as to lose his bearings.

In mechanical engineering, science and its practice are wonderfully welded together, so closely indeed that as between the man who is characteristically a devotee of research and him who is bound to its practical applications, the difference is rather one of point of view than of actual achievement. Perhaps one might even go so far as to call an engineer merely a scientist with a sense of proportion, an intuitive grip of the relative value of things in actual performance. A metrologist, for example, may spend laborious months over errors in the eighth decimal place. The engineer is just as vitally interested in the eighth decimal place as a matter of principle, but knows instinctively when to stop and when not to stop at the first or second. He also, by a sort of seventh sense of scientific propriety, understands when a quick method not comparable in refinement to a slower one will yet give results amply precise for the purpose in hand. The engineer does not deceive himself about the need for precision, nor is he willing to work by rule of thumb, but he has developed a sense of the relative importance of things, so that he does not waste labor where labor is absolutely unnecessary. The ordinary mechanic fails of being an engineer, because he does not fully understand the bearings of precision on practical performance, but trusts to what seems well enough on general principles rather than as a result of precise and well-defined knowledge. From this standpoint the engineer is a development of the scientist and at every step depends upon scientific method. As Dr. Brashear well says, there is nothing but a hazy line of demarcation between pure and applied science, for the investigations in the former find their way into the latter in most extraordinary fashion. That which is finical precision in one generation is clumsy empiricism in the next.

The mistake made by the average man in considering this matter is his lack of foresight in not realizing that a use may be found for data apparently of the most impractical character if the real relations are properly understood. It is the business of the trained engineer to grip these very ideas, and to see how some investigation made in a far off laboratory by a patient student of science may give precisely the information needed to make the difference between failure and success in some considerable undertaking. The engineer, if he is to rise to greatness, must have both a broad knowledge and a broad view of the phenomena which are being brought to light, for they must become his tools in working out the problems set before him. If he does not appreciate the bearing of results obtained in pure science he can never apply them. It is a high conception, this, of the qualifications of the engineer, the combination of scientific certainty with the insight and foresight that makes sure of its easy application, yet it is just in this that the great men of all the engineering professions differ from the grubbing rank and file. And this very thing has a direct bearing upon that other definition of the engineer which says he is the man who can do for fifty cents what any fool can do for a dollar. It is a comparatively easy thing for a man with push and self-confidence, a few useful tables and plenty of catalogs compiled by the hard-working manufacturer's draftsman, to shove through a possible job in almost any line. The "catalog engineer" indeed is a humdrum creature only too well known in the profession, but the big man who is destined in one way or another to come to the front rank must have originality and imagination, and, more than all, intuitive grasp of the relation between the results of research and the problems that lie before him.

Drill Carriages for Tunneling

HAS the day of the heavy drill in tunneling passed? This question has presented itself with increased frequency during recent years. It is a natural outgrowth of the trend toward the use of the comparatively light drilling equipment which has enjoyed such a rapid advance in popularity in the United States.

That the light drill offers possibilities in speed and economy undreamed of a few years ago cannot be denied. Manufacturers have devoted painstaking study to the improvement of the light machine and have evolved equipment which has been responsible for important advances in tunneling practice. Tunnel men have not been slow in adapting themselves to the changing standards of practice. But is the light drill the panacea for tunneling ills? Stephen P. Brown, chief engineer of the Mount Royal Tunnel & Terminal Company in Montreal, thinks not. It has its place—in stopes, break-ups and enlargements of all kinds—but for heading work the heavy drill, he thinks, is still supreme. He bases his opinion not merely upon the results of his work in the 3½-mile Canadian Northern Railway bore, but also upon an extensive study of methods employed in the principal European tunnels. In a series of three articles, the first of which appears in this issue, he arrays his facts and from them deduces his findings.

The choice of drilling equipment for a particular job cannot be decided by an arbitrary rule. There are too many variables—the size of the heading and its location, top or bottom; the toughness of the rock; the length of the tunnel between portals or shafts; and the importance which, under the particular conditions of each job, must be attached to speed of driving. No intelligent selection of tunneling methods and equipment can be made without taking all these factors into consideration.

In arriving at a just estimate of the present value of the heavy drill for tunnel work very little attention has been given, in this country, at least, to an accessory which holds great economic possibilities—the drill carriage. It is this feature to which Mr. Brown devotes most attention. Without some means of handling the heavy equipment mechanically much valuable time is lost in getting the drills at work after a round is shot. The drill carriage's function is to cut down on this lost time by extending the machines, with air hose connections unbroken, over the muck pile and into the heading by means of a long cantilever arm.

So much attention has been devoted to pneumatic hand drill development of late that the drill carriage has been pretty generally neglected. But it has a place in modern tunneling practice. The crude carriages of the past are hardly recognizable in the equipment of to-day, and yet, so limited has been the use of the modern devices in America that few engineers realize what advances have been made at the Mount Royal Tunnel and in Europe, and how the lesson learned there could be applied elsewhere.

The inherent advantages of the drill carriage are easily summed up: It minimizes the time for setting up and taking down; it allows the workmen to begin drilling unfatigued by hauling and placing heavy equipment in the heading; it saves wear and tear on the drills; it permits of the use of massive drills and supports, designed to give the best results without regard to weight; and it eliminates the necessity for disconnecting the drills from the manifold before firing a round. At Mount Royal, however, all of the tunneling was not done with drill carriages, so that this work offers an exceptional opportunity for comparing results obtained with and without the carriages. On this point the following statement by Mr. Brown is significant: "Had the drill carriages been used in the Mount Royal tunnel from the beginning a much higher average of speed, as well as greater economy, might have been attained." And this in spite of the fact that in one heading 810 ft. of tunnel were driven in 31 working days when the drilling equipment was carried and erected by hand!

So much for the heading drill carriage. Anyone who studies Mr. Brown's articles cannot fail to be impressed with his faith in this type of equipment when used under conditions for which it is suited; and, what is most important, it is faith founded upon actual performance.

Two other features of the Mount Royal work furnish food for thought. They are drill carriages specially designed for bench and for trimming work—something unique in tunneling practice. The bench drill carriage, Mr. Brown found, was the greatest money saver in the excavation equipment at Mount Royal.

Enough has been said to indicate that Mr. Brown's articles chronicle the results of new methods in a field which is gaining in importance each year, and which is still rich in opportunities for progress. For this reason no tunnel man can afford to pass them over lightly. When conditions justify its use the drill carriage seems destined to play no small part in the tunneling of the future.

Tunnel Drill Carriages—Their Economic Possibilities

First of a Series of Three Articles Discussing American and European Practice, with Particular Reference to Experiences in Driving Mount Royal Tunnel for Canadian Northern Railway in Montreal

By S. P. BROWN
Chief Engineer, Mount Royal Tunnel & Terminal Company, Limited, Montreal

When a man has succeeded in driving a single tunnel heading 810 ft. through hard rock in thirty-one working days, establishing an American record which has only recently been exceeded at Rogers Pass, he is entitled to speak with authority on tunneling methods. This remarkable feat was accomplished by S. P. Brown, chief engineer in charge of the Mount Royal Tunnel in Montreal.

One feature of the work was the use of drill carriages, about which the Engineering Record has induced Mr. Brown to tell in a series of three articles, the first of which appears in this issue. The series is based not merely upon the Mount Royal work, but also upon exhaustive studies of European practice. The tendency toward the use of lighter drilling equipment in tunneling has diverted attention, in America, at least, from the economic possibilities of the drill carriage. Tunnel men, therefore, may secure from Mr. Brown's articles new ideas applicable to their own work.

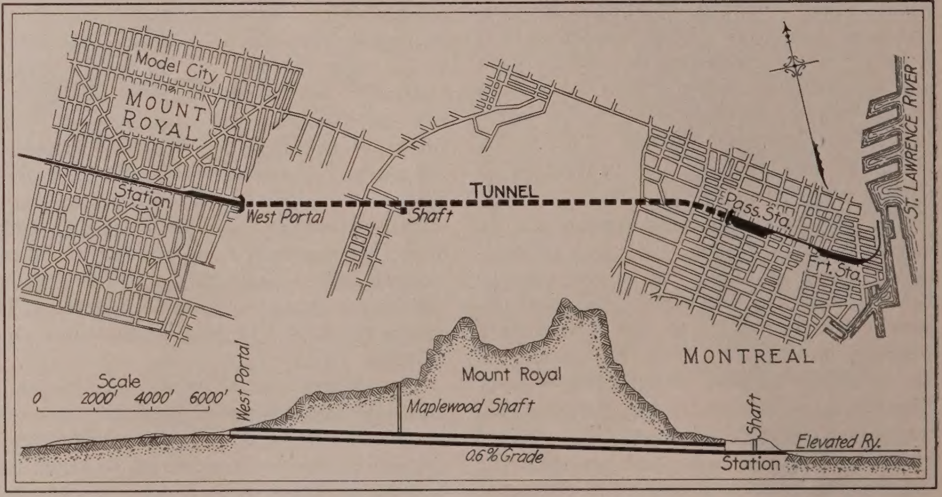
The author is a graduate of the Massachusetts Institute of Technology, and his tunneling experience has covered a wide field. In 1904-05 he was resident engineer for the United Engineering & Contracting Company on the Port Morris depression work of the New York Central Railroad and the St. Mary's Park tunnel. He was advanced to the position of principal assistant engineer with the same company, and when this firm secured one of the big Pennsylvania Railroad tunnel contracts in New York City Mr. Brown was placed in charge as superintendent of all work west of Fifth Avenue.

When the Pennsylvania work was finished Mr. Brown spent two years in France, Switzerland, Austria and Italy studying European tunneling practice as exemplified in such works as the Metropolitan Subways in Paris, the Loetschberg tunnel in Switzerland, the Tauern bore in Austria and the Formatza Valley tunnel in Italy. Returning to the United States in 1909 he became chief engineer for the Tidewater Building Company and T. B. Bryson, who had the contract for a section of the Fourth Avenue Subway in Brooklyn, N. Y. Here he remained until 1912, when he was called to Montreal to take charge of the Canadian Northern Railway's Mount Royal tunnel as chief engineer of the Mount Royal Tunnel & Terminal Company and managing engineer for Mackenzie, Mann & Company.—EDITOR.

AS THE TREND of drill design is toward the lightening of equipment, not only by improved materials and workmanship in the drill and the adoption of the hammer type in many cases, but also by the increasing use of pneumatic hand drills, the question arises as to the permanent value in modern tunnel practice of the drill carriage and drill carriage methods. Developed where the rock was hard, requiring very heavy drills, the drill carriage is the result of an increasing desire for speed in economical tunnel driving, but until the Mount Royal tunnel in Montreal was started drill carriage work was practically untried on this continent. In fact, the use of the horizontal drill-bar, instead of the old-fashioned vertical columns, was so rare as to excite unusual comment and necessitated considerable education, on behalf of the workmen, to make it a success.

While most space in this series of articles will be devoted to the work accomplished in Montreal, considerable attention will be given to other forms of drill carriages, both American and European. Part 1 will be introductory and general, with a more or less detailed description of various European and American drill carriages other than those used in Montreal. Part 2 deals with the Mount Royal heading work and carriages, with a summary of the most desirable points in heading drill carriage design. Part 3 covers the carriages used on the bench and trimming work in the Mount Royal tunnel, dealing with a type of carriage that, in the writer's belief, is entirely unique.

In the Mount Royal tunnel (see Engineering Record, June 28, 1913, page 708) a greater variety of drill carriage work has been done than on any other job. The writer is particularly familiar with this work, being in general charge of both the design and construction, first as chief engineer of the Mount Royal Tunnel & Terminal Company, Limited, and second, as managing engineer for Mackenzie, Mann & Company, Limited. The latter company, which is actually doing the work with its own forces, controls not only the Mount Royal Tunnel & Terminal Company, Limited, but also the Canadian Northern Railway System, of which the present project will form a part.

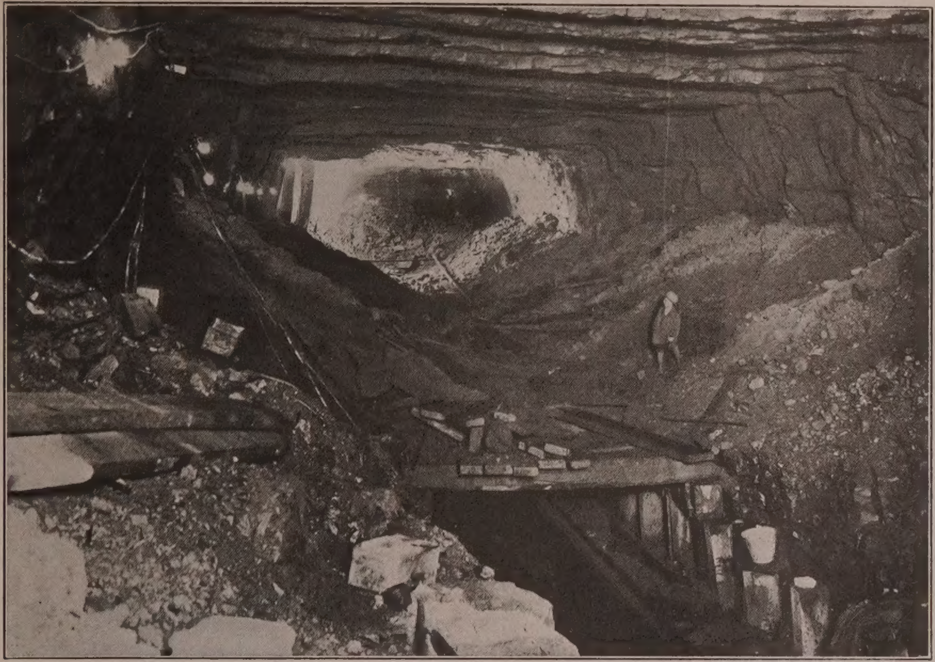


1.—MOUNT ROYAL TUNNEL WAS DRIVEN THROUGH HARD, TOUGH ROCK BY BOTTOM HEADING METHOD FROM PORTALS 3½ MILES APART AND FROM AN INTERMEDIATE SHAFT

FEATURES OF MOUNT ROYAL TUNNEL

The Mount Royal tunnel, Fig. 1, forms the entry into Montreal for the Canadian Northern Railway, the new transcontinental line. This railway lies generally between the Canadian Pacific on the south and the new National Transcontinental (Grand Trunk Pacific) on the north, and aggregates nearly 10,000 miles of track. The present tunnel and terminal development embraces electrical transfer yards back of the mountain (the terminal zone will be operated electrically at 2400 volts direct current); a model city at the west portal of the tunnel, designed at the outset for about 50,000 people; the tunnel and main passenger terminal, designed for 18 tracks on the first level, with 1200-ft. platforms; a double-track elevated viaduct across the lower town to connect the tunnel, at level grade, with the proposed harbor elevated, and an elevated freight station in the commercial part of town, capable of holding over 700 cars when fully developed.

The tunnel under Mount Royal, 3.1 miles



2.—BOTTOM HEADING TIMBERED AT BREAK-UPS TO RECEIVE MUCK WHICH IS DROPPED INTO CARS BELOW WITH MINIMUM OF LABOR

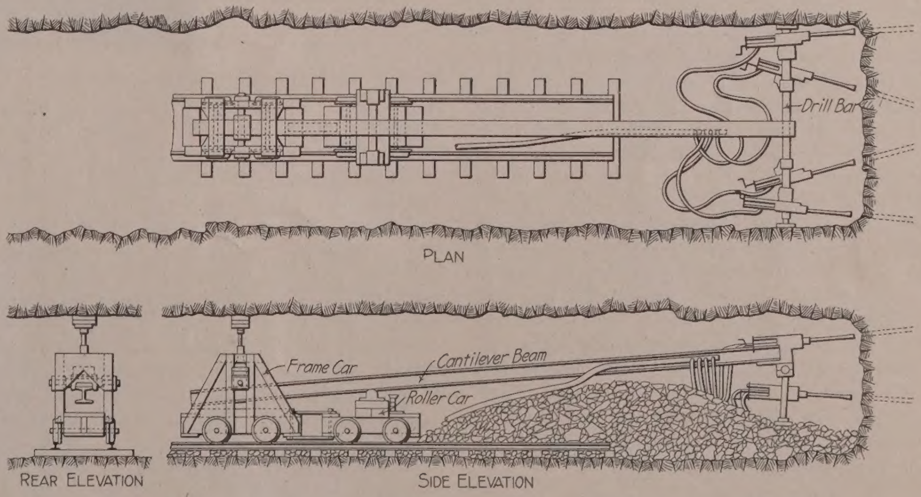
long between station sites, is double-track, roughly 22 x 30 ft. in excavation, sufficient space being allowed for a central wall and bench between the tracks. In general it will be lined throughout with concrete.

The character of the ground encountered was very diverse and in places extremely complex. The headings were in soft ground in both station sites, and at the city end the tunnel roof was in soft ground for about ¼ mile. Here a roof shield was used with O'Rourke interlocking blocks. The rock at the two ends of the tunnel was Trenton limestone, massive at the west end and somewhat stratified at the city end for the first 1800 ft. Toward the mountain proper the limestone became more crystalline, especially on the west side, where it was unusually hard and dense. The main body of the mountain is an igneous intrusion of Essexite, very hard and tough with a specific gravity of about 3.4. The number of steels dulled per foot of hole in this rock often ran from five to seven, although as a usual thing it required only about 1000 steels sharpened per day in one heading averaging 20 ft. of progress. All the main bodies of rock in the mountain were cut by numerous dikes and sheets of other very hard igneous rock, such as Bostonite, Camptonite, Tinguite, Nepheline Syenite, etc., running up to several feet in thickness. These dikes intersected the tunnel and each other in every direction, sometimes averaging several score in 100 ft. This necessitated drawing the temper of every steel to color suitable for the particular rock encountered. The ordinary method of plunging the steel proved an absolute failure. Of many steels tried, the best was F.J.A.B. (Swedish).

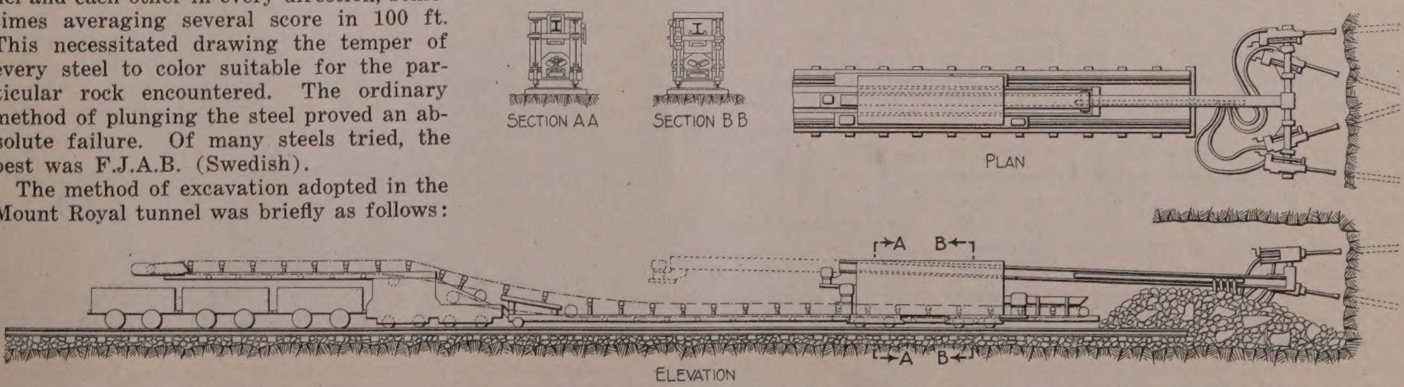
The method of excavation adopted in the Mount Royal tunnel was briefly as follows: First, a bottom heading, 7½ to 10 ft. high by 12 to 14 ft. wide was driven on subgrade along the center line. The points of attack were in the two portal station sites, 3.5 miles apart, and at an intermediate shaft, 234 ft. deep, one mile from the west portal. As the headings progressed break-ups were started, at 500 to 800-ft. intervals, along the heading, where the full-sized tunnel was excavated above the grade of the heading roof. At these break-ups, Fig. 2, the heading was timbered, so as to give a substantial roof over the tracks, upon which the upper portion of the tunnel excavation could be blasted down safely and through which the muck, thus dislodged, could slide into cars in the gangway below, with a minimum of labor. After the break-up excavation was completed the timbering was removed and the benches, remaining on either side of the heading gangway, were drilled and blasted for air-operated steam shovel excavation. This completed the entire excavation of the tunnel cross-section. Drill carriages were used, first, in the headings, second, on the bench ahead of the steam shovel, and finally for trimming the finished section. In common with all modern drill carriages, these carried the full drilling equipment assembled complete and permanently connected with the manifolds and main hose lines.

DRILL CARRIAGE TYPES

The heading carriages, described fully in Part 2 of this article, were of two types. One was a very simple affair that transported the drills to and from the heading and extended them out over the muck pile, fully erected on the horizontal bar, by means of a long adjustable cantilever arm (Fig. 3). This carriage left drills, bar and cantilever beam in the heading and was withdrawn to give room for mucking in the usual way. The other carriage (Fig. 4) was a much more complicated affair, having not only all the properties of the simple carriage, plus entire mechanical operation in extending and adjusting the bar, but also a mechanical mucking device which transported the muck from the heading



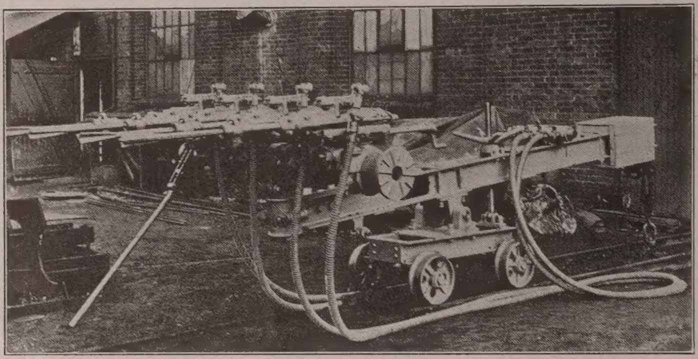
3.—IN SIMPLEST TYPE OF CARRIAGE A LONG ADJUSTABLE CANTILEVER ARM EXTENDS DRILLS ON HORIZONTAL BAR OVER MUCK PILE



4.—A MORE COMPLICATED CARRIAGE PROVIDES FOR MECHANICAL OPERATION IN EXTENDING AND ADJUSTING BAR AND WAS EQUIPPED WITH MECHANICAL MUCKING DEVICE AND TRANSPORTER through the carriage (remaining in the heading during drilling and mucking) to cars in the rear.

The bench carriages, described and illustrated fully in Part 3, were large travelers erected and moved in the heading gangway after the completion of the break-ups. They had adjustable arms or outriggers at the sides which jacked against the rib of the tunnel above the benches and supported quarry bars upon which the drills were mounted. These carriages were 30 ft. long and mounted from 8 to 12 drills each. The writer believes these bench carriages are entirely unique in tunnel work.

The trimming carriages, also fully described and illustrated in Part 3, are very similar to the bench carriages, except that they are much lighter and support not only quarry bars for mounting the heavy drills used in drilling the grade corners of the tunnel, but also platforms for pneumatic hand drill operation. They provide for the use of heavy drills where required for squaring up the "hitch" which forms the normal skewback for the concrete roof arch.



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5.—OLD EUROPEAN CARRIAGE, WITHOUT OVERHANG, MERELY TRANSPORTS DRILLS TO WORKING FACE

It is to be remembered that a drill carriage performs several functions and produces a number of economies that are fundamentally and peculiarly a part of its operation. It carried the drills to and from the working face. It enables the drilling equipment, including the supports, to be designed to give the best possible results without particular regard to weight. It enables the drill, once assembled and erected on the bar, to remain so until it has to be removed for repairs. The drills are not only left on the bar while being moved, but they are never disconnected from the manifold, nor is it necessary to disconnect the main feed hose from the manifold. Thus the only connection to be made in setting up is that between the main feed hose and the supply pipes in the tunnel.

ECONOMIES OBTAINABLE

It is evident, therefore, that several important economies are directly obtained. The time required for setting up and taking down is minimized. The workmen are fresh when they commence drilling. The drills are not abused in dragging them in and out over the muck, and broken parts are rare. The drills and hose are always clean and free from grit and dirt other than dust, which means a vast saving in wear. The equipment, especially that supporting the drills, may be so massive as to practically eliminate vibration, thus greatly improving the rate of drilling. The whole procedure falls naturally into a regular routine, systematizing itself so as to reduce lost motion and delays to a minimum.

There are fundamentally three types of modern drill carriages for heading work. The first is the old European drill carriage with no material overhang, designed merely for transporting the drilling equipment to and from the working face (Fig. 5). The second is the cantilever drill carriage, which not only transports the drills, but extends them, fully erected on their drill bar, out over the muck pile to the operating position (Fig. 3). The third is the muck-handling drill carriage, which adds a mechanical conveyor to the second type, in order to expedite the mucking where the volume of excavation is very considerable (Fig. 4).

EUROPEAN DRILL CARRIAGES

The first of these types was originally designed for the enormously heavy and cumbersome Brandt drills, as used, for instance, in the Simplon and Tauern tunnels. Fig. 6 shows such a carriage, with the Brandt drills actually working, in the Tauern tunnel. This picture was drawn by an Austrian artist, in the heading of the Tauern tunnel, to be used as a memento of the international celebration when the tunnel was holed through connecting Austria and Italy. It was given to the writer by Carl Redlich, president of the company building the tunnel. It is interesting to note not only the massiveness of everything but the flexible steel pipe connections between the manifold and the drill. This is required by the high water pressure used to operate the drills, often exceeding 1500 lb. per square inch. It will also be observed that the heading is quite clear of muck. This condition is common to all drill carriages of this type where the overhang of the cantilever arm, supporting the drill bar, is so small as to preclude erecting the drills before the heading is mucked out.

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6.—EARLY TYPE OF EUROPEAN CARRIAGE DESIGNED FOR ENORMOUSLY HEAVY AND CUMBERSOME DRILLS

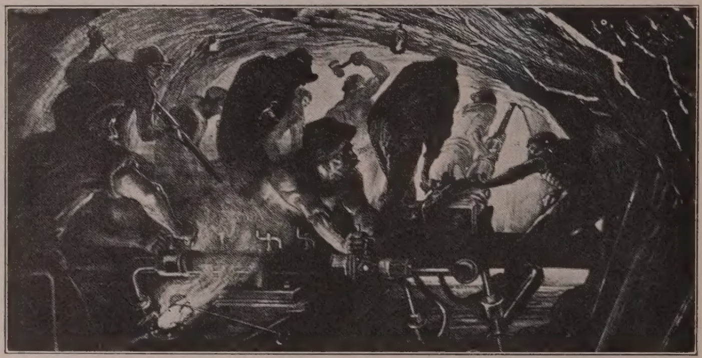


Fig. 5 shows a later adaptation of this type of carriage, being the second designed for use in the southern end of the Loetschberg tunnel in Switzerland. The same absence of overhang will be observed. In this case air drills of the reciprocating type were used, both drills and carriage being made by the Ingersoll-Rand Company. The first carriage designed there anticipated two horizontal drill bars, one above the other, but was quite impracticable. Even the one illustrated in Fig. 3 was too awkward to handle in practical use. The main reason for this awkwardness was, first, that the point of support of the cantilever arm was entirely too high for the breadth of gage and length of wheel base; and second, that, as there was no longitudinal adjustment in this arm, a very massive counterweight was required to offset the drill bar and equipment at the other end. This brought the center of gravity of the entire carriage very high, with the load widely separated on a somewhat flexible support. The net result was such frequent derailment that its manipulation became uneconomical.

The carriage illustrated in Fig. 7 was designed to correct much of this trouble; it was also built by the Ingersoll-Rand Company. It has no overhang, the idea of simultaneous drilling and mucking not having been then developed. The drill bar is pivoted over the center of the truck and may be lowered right onto the frame so as to increase greatly the carriage's mobility during transportation.

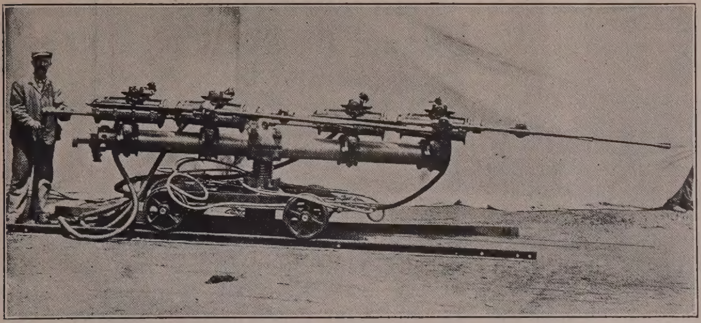
It was in this tunnel, although at the northern end where Myers drills were used, that the famous record of 1013 ft. in one month was made. The writer regrets that he has no direct illustrations connected with that end.

At first thought a carriage requiring a clean heading for operation seems a rather cumbersome affair, but when the conditions are fully analyzed the economies are evident. In the European headings, where this type of drill carriage originated, the quantity of muck was insignificant compared with the headings used, for instance, in the Mount Royal tunnel. In Europe the common heading of 6 x 9 ft. gives an excavation of only 2 cu. yd. per running foot. In the Mount Royal heading, running up to 10 x 14 ft., the volume of muck was sometimes over 5 cu. yd. per foot. Thus the actual quantity of muck to be cleared away after a blast in the European heading is so small that it can be done in a very short time.

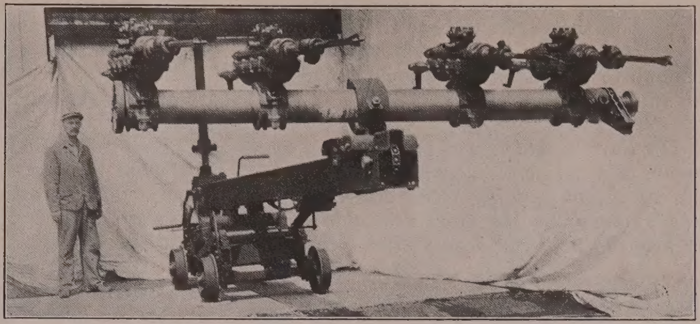
It is quite common in the very small headings, where double tracking and turnouts are difficult, to design, for the actual heading, work cars so small and light that they may be merely tipped off the track to one side when empty to permit the loaded cars to pass out. The drill carriage had, of course, to be side-tracked, and as these side tracks occurred only occasionally, where the heading had been purposely widened, the mobility of the carriage was of very great importance.

CARTER ADJUSTABLE CARRIAGE

The writer believes that one of the first carriages designed with an adjustment for extending the drilling equipment out over the muck pile, was built also by the Ingersoll-Rand Company, although its details were not made public, nor was practical application made until quite recently. This, the Carter patented drill carriage, is illustrated in Fig. 8. As will be observed the carriage consists of one truck, of rather short wheel



7.—MOBILE CARRIAGE DESIGNED TO CORRECT CERTAIN FAULTS IN THE DEVICE SHOWN IN FIG. 6



8.—CARTER DRILL CARRIAGE, THE PIONEER DEVICE WITH ADJUSTMENT FOR EXTENDING DRILLS OVER MUCK PILE

base, with a permanently extended cantilever arm, hinged for vertical movement over the center of the carriage. The whole device is low and compact. The beam consists of a light box girder which forms a track upon which the drill bar, mounted on a small carriage, travels forward and back. When the drill carriage is travelling out and in from the heading the drill bar is run back directly over the center of the truck or a little back of this point, so as to counterbalance the extended arm and bring the center of gravity of the whole apparatus well within the wheel base of the truck. This movement of the drill bar on the arm is actuated by means of a sprocket chain running over a crank wheel on the rear of the carriage. The cantilever arm is supported, during the movement of the drill bar, by either blocking off the muck pile or bracing the rear end down from the roof at a point behind the fulcrum.

PLACING DRILL BAR

After blasting, the muck is shoveled off the track to a point sufficiently near the face for the cantilever arm to place the drill bar in its proper position. The carriage is then run into the heading, hard up against the muck pile, and the drill bar run into position and jacked firmly between the sides of the heading. Next, the bar is disconnected from the beam and the carriage drawn back to a siding out of the way of the muck trains. This operation is reversed when the drilling is completed, and the carriage carrying the whole equipment is run back to a siding out of range of flying rocks.

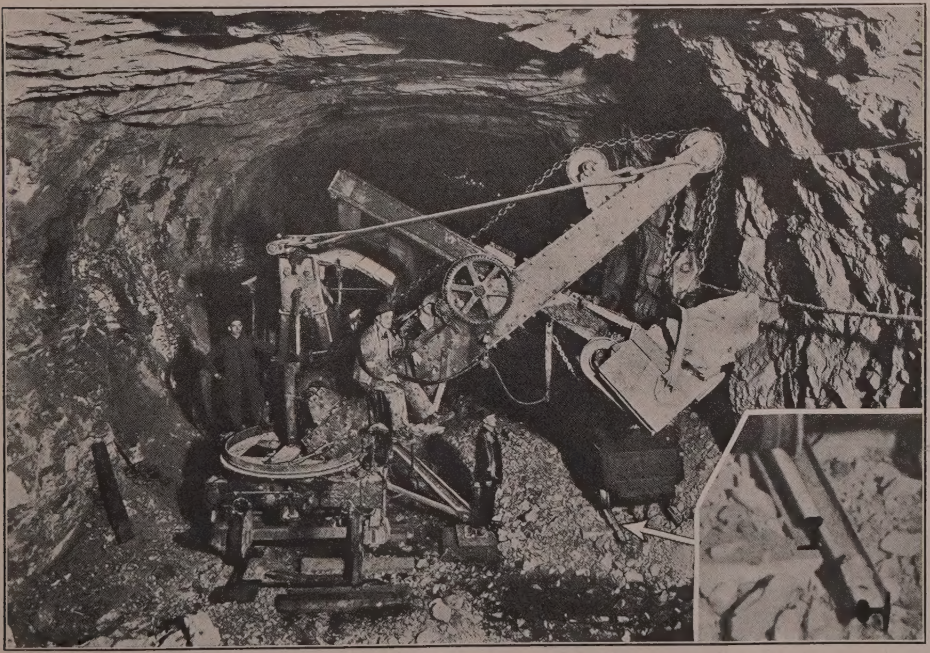
This is an extremely good apparatus, although open to some criticism. It embodies many valuable novelties and if properly proportioned may be made durable and effective. A lateral swing should have been provided at the point of support in the main truck. The drill bar in this carriage should be exceptionally heavy to avoid vibration. The drills should be mounted on column arms or some form of movable saddle to give them a vertical adjustment. The grips of the end jacks of the bar should be so designed as to prevent the drills from rotating the bar, or an auxiliary leg should be used. The beam should be, in itself, slidable through the support on the truck, so that when the carriage is being moved out and into the heading it could be slid back to bring its center of gravity nearly over the center of the truck and reduce the sway of the long extended member. The principle of the carriage, however, is good and has, the writer understands, already done satisfactory work. The length of the beam will, of course, depend on the character of the rock and the manner in which it is blasted out. If the method of drilling and blasting the heading is properly devised and executed the bulk of the muck will be piled a few feet back from the face and will not extend sufficiently along the gangway to cause material trouble in clearing the tracks expeditiously to within reach of the face.

Slick sheets are often used in heading work to expedite the mucking, both in Europe and America. In Europe the cars and drill carriage are both usually run off the rails out onto these slick sheets, which, of course, are kept as close to the heading face as possible. In the Mount Royal tunnel, however, no attempt was made to run either muck cars or drill carriage onto the sheets in this manner. The steel plates were cut about 5 x 10 ft. and laid crosswise of the tunnel on top of the rails, where they did not form part of the track itself, as will be described later. As the heading was mucked out after each blast, ties were laid in advance and "drive rails" were used to extend the tracks as the work progressed.

Drive rails consist of 15 to 18-ft. lengths of standard rails, weighing 40 lb. in the case of the Mount Royal tunnel (see small enlarged detail in lower right-hand corner of Fig. 9). They are laid on their sides with the ball of the rail fitting into the sockets against the web of the rail already spiked in place. They are held in this position by temporary spikes and driven ahead a few feet at a time as the muck is cleared away and ties placed. The cars can thus be run forward on the balls of these capsized rails right up to the muck pile, or last slick sheet, at all times. When the full length has been driven out the drive rail is turned right side up and spiked lightly in place. As soon as two lengths have thus been driven out they are taken up and full length rails laid in their place ready for the process to be repeated. This method was used both in the heading and at the steam shovel (Fig. 9), where it was of great importance that the muck cars should be kept hard up against the muck pile at all times. The writer has given this detail of drive rails because he has found, to his great surprise, that it is an important economy.

SLICK SHEET TRACK

In all drill carriage work in Montreal the track used near the face, within the radius of flying muck, was made up in lengths of about 5 ft. so as to make up exactly a standard rail length selected. In these sections the rails were riveted to steel sheets of the same length as the track section and about a foot wider than the track. Drive rails were unnecessary here as the sections were short and the track was always well ahead of the drill carriage. After the heading was fully mucked out before blasting the advance ties were laid and the new section of slick sheet track laid down on them without spikes, being merely connected to the last section by ordinary strap fish-plates. Each slick sheet had holes punched in its corners for convenience in handling. As the work progressed the track sections were taken up behind and replaced with standard rails, spiked to the ties laid in advance.



9.—SHOVEL LOADING MUCK INTO CAR ON "DRIVE RAILS," LAID FLAT AS SHOWN IN DETAIL IN RIGHT-HAND LOWER CORNER OF PICTURE, THUS ALLOWING CAR TO RUN RIGHT UP TO MUCK PILE

After a blast the muck was easily and rapidly cast off the slick sheets to the side of the track until the track was cleared near enough to the face for the drill carriage to be run in.

[*In Part 2, which will be published next week, Mr. Brown discusses in detail the Mount Royal heading work and carriages and summarizes the most desirable points in heading drill carriage design.*—EDITOR.]

No Attempt Yet to Fix Prices in Federal Valuation

Division of Valuation Is Collecting Data as to Market Prices, and Studying Experiences of Carriers as to Actual Costs

EXCEPT for the tentative prices applied to certain railroads selected for initial valuation the Division of Valuation, Interstate Commerce Commission, in connection with the valuation of the carriers, has made no attempt to fix prices. The commission has the following to say on the subject in its annual report recently transmitted to Congress:

"It is manifestly of first importance that correct prices should be applied, and the commission has not felt up to the present time that the information before it was sufficient."

MARKET AND ACTUAL PRICES

"In the determination of prices the two principal sources of information are the market prices and those actually paid by the carriers. By market price is meant the price at which dealers profess to sell. Such prices can be obtained from catalogs, quotations, correspondence and personal investigation. The commission has collected and is collecting in all these ways a great mass of information, which is being arranged and classified. While these facts will be of assistance in finally establishing a just price, it is apparent that they cannot be alone relied upon. The prices thus obtained are not those which would be paid by an actual purchaser if a railroad were under construction.

"In applying the test of actual cost, however, it would not be proper to use the prices ascertained from the experience of a single railroad. In this view carriers have been required to furnish information as to prices actually paid for the various items, including labor, which enter into the construction of a railroad. Most of these figures have been received and are being tabulated.

"But the figures so furnished should not be relied upon without examination of the records of the carriers. Accountants in each district make such examination and obtain much additional information of different kinds with respect to cost of construction. Since, however, the prices obtained from a single property are not sufficient, it will not be possible to reach a just and certain conclusion until these accounting investigations have been extended to an adequate number of railroads in each section."

OVERHEAD CHARGES

"There is still another reason why it has seemed best to defer for the immediate present any attempt to put an actual money value upon the inventories which are being prepared. It seems to be universally conceded that in addition to the amounts obtained by the application of unit prices to the quantities shown upon the inventory, certain additions, commonly known as overhead charges, must be made. These items are of significance and no opinion should be expressed upon them without the fullest possible information. Here, again, an examination of the accounts of carriers for the purpose of ascertaining what these items have actually amounted to in the past is of first importance, nor would it be safe to accept the result obtained from one or even from several carriers.

"For the above reasons the commission has believed that it was wise to defer the application of prices and the final statement in dollars of the cost of reproduction new, and the cost of reproduction new less depreciation, until such information was available as would permit the formation of a reliable opinion. It should be noted that this will not involve delay in the final completion of the work, since as soon as the application of prices can be properly begun the work can be speedily brought up."

PRICES ON SIX ROADS MAY BE FIXED NEXT MONTH

In this connection a circular issued by Thomas W. Hulme, general secretary of the Presidents' Conference Committee, states that "it is expected that the consideration of unit prices by the cost data bureau of the Division of Valuation, Interstate Commerce Commission, will permit of the application of prices in February, 1916, to the following roads: Texas Midland; Kansas City Southern; Atlanta, Birmingham & Atlantic; Norfolk Southern; Elgin, Joliet & Eastern, and San Pedro, Los Angeles & Salt Lake. It is the intention of the director of valuation that the carriers shall be afforded an opportunity to discuss these prices with the local government representatives before the member of the Engineering Board sends the inventory to Washington, following which an opportunity will be afforded the carriers' organization and the representatives of the states to consider the inventory and offer other suggestions in connection therewith."

October Railroad Earnings Continue Upward Trend

GROSS operating revenues for October, 1915, on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1,323 per mile, showing an increase of $152 or 13.0 per cent as compared with October, 1914. Operating expenses were $815, an increase of only $28 or 3.6 per cent. Net operating revenue, therefore, was $508—an increase of $128 or 32.4 per cent, and operating income was $456—an increase of $123 or 36.9 per cent. The comparison is with the lowest October in six years; in comparison with the average October for five years the gain is only 19.6 per cent. The operating ratio was 61.6 per cent, as compared with 67.2 per cent in October, 1914, and 67.8 in October, 1913. Considering the three main districts, the respective ratios for October, 1915, and October, 1914, were as follows: Eastern district, 63.4 and 70.5; Southern, 66.2 and 73.7; Western, 58.2 and 61.9.

THE TOTAL CUT from all of the national forests of the United States last year was 689,000,000 ft. b.m.

Field Lithography Permits Rapid Production of Maps

Though Specially Developed for Military Operations, the Process Could Be Used to Advantage by Civilian Engineers

By D. A. TOMLINSON
Company A, First Battalion of Engineers, Illinois National Guard

FIELD LITHOGRAPHY, or more properly, "zincography," has been developed by the army engineers to meet the need for quick preparation and duplication of maps giving complete and accurate information about the surrounding country in military operations. All data brought in by scouts and reconnaissance parties must be distributed to the various officers very rapidly, for news 24 hours old is worthless. When an army is advancing into enemy territory, about which little information is available, parties of sketchers in advance of the main army must make rough sketches each day of as much ground as the army will cover the next day, and in the evening these sketches must be assembled into maps and distributed. As these must be made in all sorts of conditions, night or day, tracing and blueprinting has serious drawbacks. Hence the lithographic process has been developed. Because it could be used to advantage in many cases by engineers in civil life it is described in detail.

THE PROCESS

A drawing is made on specially prepared tracing paper, and is then etched on a zinc plate, from which any number of copies can be made. The plate can be engraved in less than half an hour, and several impressions a minute can be made.

The drawing is made on the smooth side of a special "Autographic Transfer" paper, which is so sensitive that it records and reproduces finger prints, with an ink that is a mixture of four parts autographic ink and one part liquid touche. While the drawing is being made the zinc plate is prepared to receive the impression. It is first washed with clean water, and then with caustic soda or pumice stone, to remove any dirt or grease. It is then sensitized by a bath in a solution of dilute nitric acid (½ oz. of nitric acid and 32 oz. of water). To neutralize the oxidation caused by the nitric acid the plate is bathed with a dilute solution of hydrochloric acid (¼ oz. hydrochloric acid to 8 oz. of water). The plate is then thoroughly washed with clean water and dried, and is ready for the impression.

MAKING THE IMPRESSION

The drawing, backed up with two or three sheets of paper, is dampened and placed face downward on the plate, which is run through rollers several times. An ordinary laundry wringer will do. The ink on the drawing is transferred to the plate, and the drawing is peeled from the plate, coming off clean. The plate is washed with clean water, and the impression is strengthened by a bath with a solution of turpentine and printers' ink. It is then washed in gum arabic. The plate is dried and washed with turpentine and asphaltum. It is dried again and washed with water. Then printers' ink is applied with a roller until the lines stand out distinctly, after which it is dried and powdered with powdered rosin and French chalk, which protects the lines from the etching solution. During this preparation for etching the plate is washed and dried so often that the militia engineers become expert "fan artists" while learning the process.

ETCHING THE PLATE

The plate is now ready to be etched. The etching solution is a mixture of phosphoric, tannic and chromic acids. These are carried in solid form, and are dissolved in water in the following proportions: 5½ oz. phosphoric acid to 10 oz. water; ½ oz. tannic acid to 4 oz. water; 4 oz. chromic acid to 6 oz. water.

From these diluted acids, the etching solution is made in the proportion of 1 oz. phosphoric, 1½ oz. tannic and 1 oz. chromic acid, mixed in that rotation with 12 oz. of strained gum arabic (dissolved in water, in the ratio of 2 lb. of gum arabic to 1 gal. of water). The plate is bathed for several minutes with this solution, is then washed, bathed in gum arabic, and dried. The impression is washed out with a solution of turpentine and asphaltum, dried and washed with clean water, and the plate is ready for printing. The preparation of the plate is the longest part of the process and sounds formidable, but after a little practice can be done very rapidly.

PRINTING

For the printing the plate is dampened slightly with a weak solution of gum arabic and water, and is then thoroughly rolled with printers' ink (the ink adhering only to the impression). Paper is placed on the plate, covered by a rubber blanket or other suitable backing, the plate is passed through a pair of rollers, and the print is removed. This is repeated indefinitely, several copies a minute being taken off.

The plate can be stored indefinitely, altered or revised, and more copies taken off; or the impression can be removed and the plate prepared for another. Once the impression is on the plate, prints can be obtained rapidly, are durable, do not fade, and have an excellent appearance. Moreover, they can be made under almost any conditions that may arise, and the necessary equipment is small, light and portable.

Water Consumption Lowest Where Most of It Is Metered

WATER consumption per capita in the city of Tacoma, Wash., is reported as 430 gal. per day, the largest rate in the United States. The lowest rate is reported from Woonsocket, R. I., where the consumption is 34 gal. per capita per day. In the former city 8 per cent of the water is metered and in the latter 98 per cent. The tendency of meters to curtail water consumption is illustrated by a comparison of statistics for twenty-six cities in which the entire supply is metered with those for twenty-six cities in which only 25 per cent of the service is metered. In the former group the average daily consumption per inhabitant is reported to range from 42 gal. in Brockton, Mass., to 179 gal. in Columbia, S. C., and to exceed 100 gal. in only seven cities. In the twenty-six cities where service is not metered, on the other hand, the rate is reported to vary from 43 gal. in Savannah, Ga., to 430 gal. in Tacoma, Wash., and in only three of the latter cities did the rate fall below 100 gal. per capita per day.

Reinforced Concrete Combined with Timber for Coal Pockets and Trestle

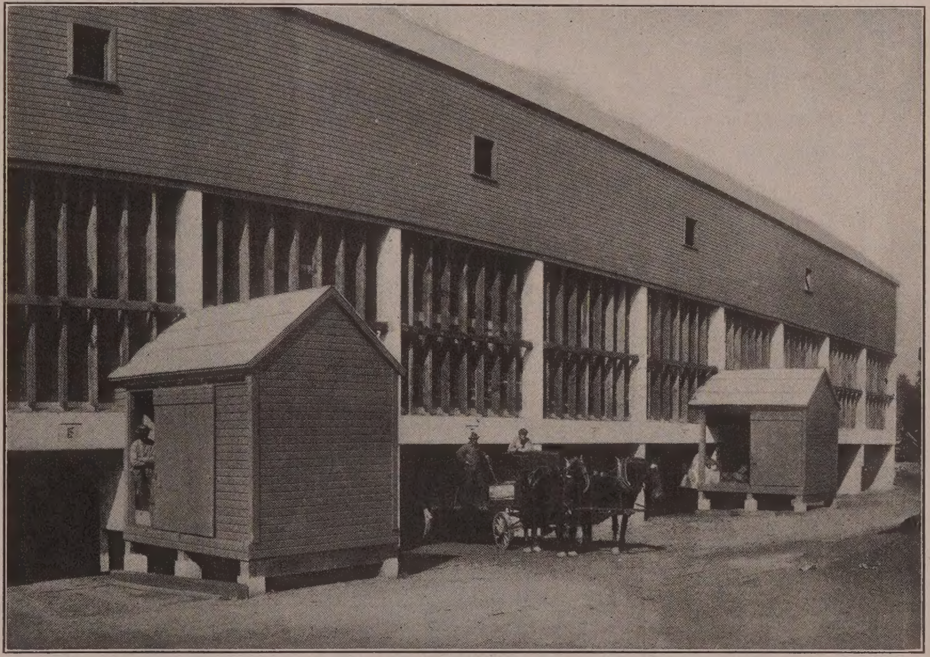
Combination Structure at Poughkeepsie, N. Y., on Central New England Railway Designed for Future All-Concrete Construction

By CHARLES F. DINGMAN

Engineer, Flynt Building & Construction Company

SEVERAL tentative schemes were suggested for meeting the special conditions encountered in replacing the old wooden trestle and coal pockets of the Collingwood & Seaman yard at Poughkeepsie, N. Y., on the Central New England Railway. The accepted design, using a combination of timber and reinforced concrete, best fulfilled all the requirements and called for the least expenditure per ton of capacity.

The engineers of the railway company stipulated that if a wooden trestle were built the pockets must have supports entirely independent of the track bents. The old bents were spaced approximately 16 ft. apart on centers, while the railway company's engineers advised reducing the spacing to 14 ft. The owners desired to maintain the old spacing and to have as wide a dumping space as possible between the track stringers.


EFFECTIVE COMBINATION OF TIMBER AND CONCRETE FOR COAL POCKETS

The adopted design keeps the 16-ft. spacing by using reinforced-concrete bents carried on mass concrete piers, which could be built around the old, low masonry piers and reinforced-concrete stringers 18-in. wide. The coal pockets are built mainly of timber, with concrete division walls and lower outside stringers, as shown on the drawing, supporting the wooden beams and studs.

GENERAL FEATURES

The Central New England Railway, which serves the trestle, is about 21 ft. above grade at this point, and this allows the cars to be dumped into the pockets, under which the wagons can be backed and loaded. The grade from the siding to the trestle is very slight. The trestle is built on thirteen reinforced-concrete bents and one end retaining wall which supports the approach fill and serves as the end bent.

It was the original intention to use the old rubble masonry foundations, which were believed to extend down to firm bearing, by simply incasing them with the new concrete. Further inspection, however, disclosed the fact that they were only just below the surface of the ground, which made it necessary to remove them entirely and build new footings on firm bearing and below frost line.

The completed structure is 210 ft. long and has a net capacity of 1680 tons of anthracite coal. The timber shed presents no unusual features except the allowance of very ample clearances at the sides and tops of the railroad cars and the use of Eterno asbestos roofing. The latter was applied in sheets 40 x 32 x 5/16 in. and nailed directly to the rafters. The end joints were lapped 4 in. and the side joints butted and covered with 4 x 32 x 5/16-in. batten strips.

PARTITIONS AND TRACK STRINGERS

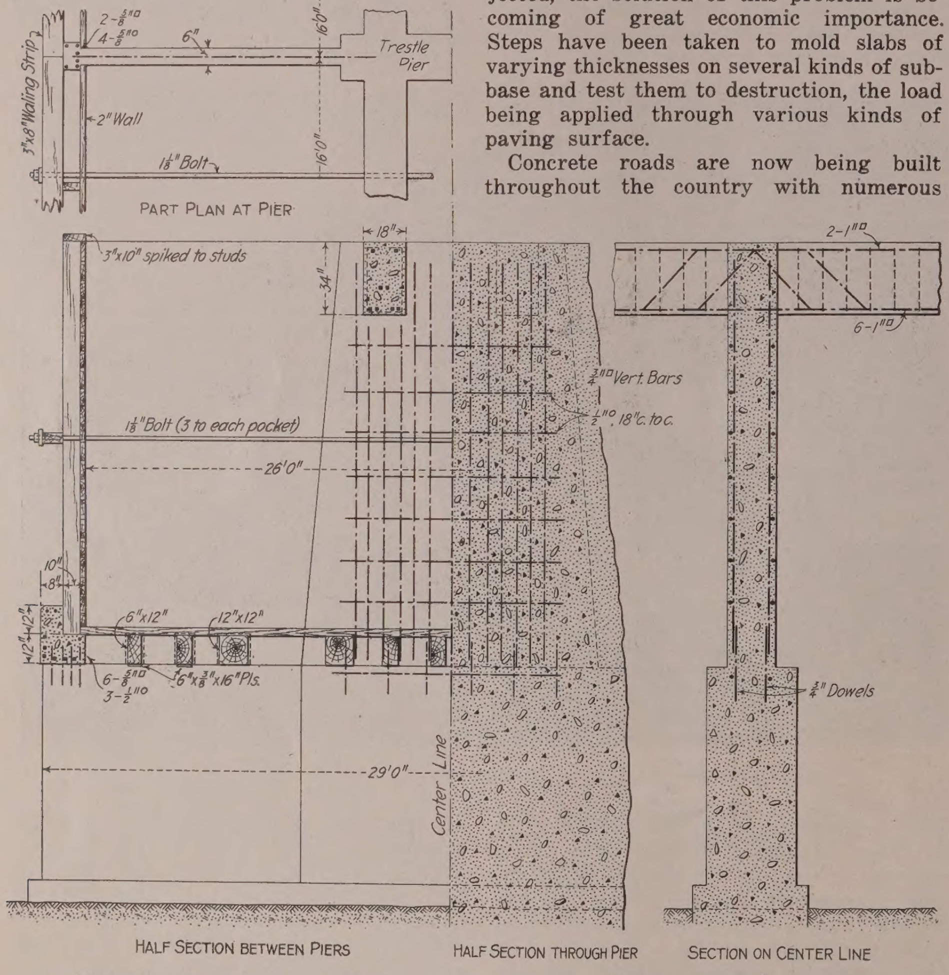
The partitions between bins are of concrete 6 in. thick, reinforced with a sheet of 24-gage Corr Mesh ¾ in. from each face. The inner end of the partition is retained by the trestle bent, while the outer end is held by the end post, which also serves to retain the ends of the wall plank. Much of the old yellow-pine plank and timber from the original structure was in good condition and could be used again. All new timber and plank was Douglas fir. All woodwork in the pockets was treated with three brush coats of Avenarius Carbolineum at the ends of each piece as an insurance against decay.

In the design of the track stringers a

loaded car, having a total weight of 210,000 lb. was assumed to have one of its trucks over a pocket, thus loading each beam with two concentrated loads of 26,250 lb. spaced 5 ft. apart. A unit stress of 12,000 lb. per square inch was allowed in the steel reinforcement. The track rails were secured directly to the stringers by Carnegie standard rail clips, held by anchor bolts embedded in the concrete.

SPECIAL REINFORCED-CONCRETE STRINGERS

A special feature of the design is the reinforced-concrete stringer which serves to retain the bottom of the studs along the sides of the coal pockets. The outward pressure at the bottom of a coal pocket is very great—in this case about 700 lb. per linear foot. This design in reinforced concrete was adopted after several other coal trestles were visited in an effort to find a satisfactory timber design for this point.



DETAILS OF REINFORCED-CONCRETE BENTS AND STRINGERS—TIMBER COAL POCKETS

The stringer also serves to carry out one of the general ideas of the design, which is that the entire wooden part of the pockets may be removed and reinforced-concrete construction substituted at any future time. The wooden part is also designed with the idea that if the floor system of any pocket should fail no additional stress would come on any part of the track structure.

A mixture of 1:3:6 concrete was used for the footings, requiring 214 cu. yd.; for the piers a 1:2½:5 concrete was used, requiring 338 cu. yd., while 122 cu. yd. of 1:2:4 concrete were used in the bents, track stringers, partitions and side stringers. Dragon Portland cement, crushed trap rock (1½-in. for mass concrete and ¾-in. for reinforced work) and Kingston sand were used throughout.

The structure was designed and constructed by the Flynt Building & Construction Company, of Palmer, Mass.

To Determine Proper Concrete Base Thickness for Roads by Test

THE U. S. Office of Public Roads and Rural Engineering has begun a series of tests at Arlington, Va., to determine the proper thickness of the concrete base for roads of different types when subjected to loads of different magnitudes and when placed on various kinds of sub-base. In view of the increasing intensity of wheel loads to which roads are now being subjected, the solution of this problem is becoming of great economic importance. Steps have been taken to mold slabs of varying thicknesses on several kinds of sub-base and test them to destruction, the load being applied through various kinds of paving surface.

Concrete roads are now being built throughout the country with numerous kinds of aggregate and under various construction methods. There is a noticeable difference in the amount of wear suffered by these surfaces, and it is a much mooted question as to which kind of aggregate will prove most economical under particular conditions of traffic and location of source of supply.

WEAR TO BE MEASURED

In order to gain information of value in this connection an instrument has been devised and constructed in the concrete laboratory at Arlington, Va., for the purpose of measuring the amount of wear of concrete roads of different types. Periodical wear measurements will be taken of concrete-road surfaces on which the traffic conditions are known.

It has long been known, the Office of Public Roads states, that concrete is not elastic, but attains permanent deformation under working loads. During the course of a series of tests on reinforced-concrete slabs recently made by the Office of Public Roads and Rural Engineering, and now being continued, it was very forcibly brought to the notice of the observers that the concrete continued to deform slowly as long as the load was applied. This fact is significant, as it helps to explain certain stress conditions in concrete roads and bridges when subjected to temperature changes. In order to study this phenomenon more fully, a series of tests has been begun to determine the "flow" of concrete and reinforced concrete when subjected to direct compression and to bending stresses. Working conditions will be maintained on the specimens as long as they exhibit "flow," and finally the specimens will be broken in comparison with like specimens that have not been previously loaded.

Twenty-Foot Depth of Driftwood Buckles Automatic Gates

AUTOMATIC crest gates 15 ft. high and 18½ ft. wide are used on the new dam at Austin, Tex. They were placed in service early in 1915, and within a few months of their installation demonstrated their adaptability to their purpose. They passed not only ordinary floods satisfactorily, but also one heavy flood carrying from 50 to 60 acres of driftwood which had accumulated in the pond prior to the full opening of the gates. With 14 ft. of water going over the crest, the velocity and volume were such that large trees were carried through the space between the piers and over the upper surface of the gates. When the spread of the branches was larger than the openings, the force of the water broke off the limbs and carried the broken trees through.

However, in the largest storm experienced since the dam was completed, which occurred the latter part of September last, a depth of driftwood of about 20 ft. accumulated in front of the structure, and, upon the opening of the gates, jammed between them and the crest of the dam, buckling them upward. As a result some of the gates will have to be replaced. The buckled gates were carried over the spillway and destroyed.

The gates were designed to resist only the forces acting in a downstream direction. The accumulation of driftwood to a depth below that of the gate surface when in the horizontal position was not considered as a possibility. To insure safety, however, from unforeseen effects of drift, the engineer's original plans provided for suitable log booms upstream near the head of the lake. Had these been constructed the damage would probably not have occurred.

It is hardly to be expected that such an accumulation of driftwood will again be experienced. This was the heaviest flood since the construction of the dam, or that has occurred in many years, and naturally it cleared out all the floating material within the reservoir area.

TWO HUNDRED EIGHTY-THREE KILOWATTS per barrel of oil is the normal operating record claimed for the Long Beach steam generating station for the Southern California Edison Company. The plant has a capacity of 47,000 kw. and is equipped with Curtis vertical turbines, operated condensing, under a high load factor.

Privately Financed Sewer System for Small Town Produces $2,000 Yearly Revenue

Citizens of Troy, Pa., Secure Public Improvement Without Exceeding Limit of Bonded Indebtedness—Tannery Wastes Cause Trouble

By HENRY W. TAYLOR
Consulting Engineer, Albany, New York

FINANCED entirely by private capital the sewerage system and treatment plant of the borough of Troy, Pa., involving a number of uncommon legal features described in the Engineering Record of Jan. 16, 1915, page 79, have just been completed. Although the borough could not pay for a sewer system without exceeding the limit of its bonded indebtedness, such a system has been supplied by private capital and has an earning power such that the total cost of $25,000 will, in a 20-yr. period, be reduced to not over $7,000. No tax for the installation or maintenance of the system is imposed upon the general taxpayer who has no desire for a sewer system or connection thereto, while such an individual is now afforded, without charge, the opportunity of connection, should he desire to pay $10 a year for same. The borough has the right to take over the system at any time by purchase of individual interests, and in the meantime, without municipal taxes has the use of a system which it could not itself legally afford.

The system, as installed, includes 22,000 lin. ft. of 6, 8 and 10-in. sewer with 80 manholes and four double inverted siphons consisting of duplicate lines of 8-in. Universal cast-iron pipe with special manholes and screens. The treatment plant consists of an Imhoff tank with superstructure over half of tank, containing a hypochlorite dosing apparatus, a back-flooded 18-in. outfall sewer and a sludge bed. The whole system was installed with special care and the inverted siphons required for stream crossings, long and deep cuts, repairs to improved state highways, interference with existing drains, water pipes and service connections, considerably affected the total cost of the work. The treatment plant was installed in about 10 ft. of ground water and the major part of the excavation lay in a semi-quicksand.

GROUND WATER INFILTRATION

As the sewer construction committee supplied all material for the laying of the sewer it was possible to take especial pains with construction in wet trenches. A good quantity of cement was used in the joints which were wrapped with muslin in the wetter trenches. There was a large percentage of wet trenches where the sewer will be under a considerable hydrostatic pressure from ground water levels, but when the system was completed and all dead ends closed the ground water infiltration amounted to about 5500 gal. per mile of sewer in the trunk line and the main street laterals. It is thought by the engineer that during extremely wet seasons this ground water infiltration will be increased to about 7000 gal. per mile, but the results of care in laying the sewer amply justified the extra cost of material and inspection. Measurement of infiltration was made by the trapezoidal weir in the outlet manhole of the Imhoff tank.

The sewer system receives wastes from a tannery, a creamery, and the domestic sewage of the borough. The tannery wastes gave rise in warm weather to a distinct odor which escaped from the hook holes of the manhole covers. The manhole covers are cast without vent holes. The nuisance from the tannery wastes developed before these wastes were diluted by domestic sewage from house connections to the system, and the tannery wastes were first turned into the system for the purpose of studying the results of the tannery odors and their effect upon the sewer system.

TANNERY WASTES CAUSE TROUBLE

It was found that a standard 45-deg. drop manhole, with a drop of 2 ft., was not suited to undiluted tannery wastes, the drop being so abrupt as to give rise to a frothing scum which filled the drop manhole from the floor to the manhole casting with brownish soap suds. These suds trapped the sewer ventilation and produced a distinct nuisance in the next lower manhole. The drop in the manhole was changed so as to form a ramp in which the 2-ft. drop was made in a distance of 10 ft. and since this change has been made the suds formation has been prevented.

The three inverted siphons on the trunk line air-trapped the trunk sewers into three separate sections. The high manhole in each one of these sections ventilated its particular section and a distinct nuisance, with the undiluted tannery wastes, was observable during warm weather. It was first thought that each section could best be vented through lateral sewers extending to the higher points of the borough, but it was finally decided to install air lines between the two inverted siphon manholes so that a continuous ventilation could take place from the treatment plant to the end of the trunk sewer at the tannery. At this point a 20-ft. riser was installed and the ventilation from the whole sewer line will be returned to the tannery property. Between the top of the vent riser and the inlet manhole of the Imhoff tank, which acts as an air inlet, there is a difference of elevation of about 130 ft.

LOOSE-LEAF ACCOUNTING SYSTEM

The sewer construction committee purchased its own materials and built the treatment plant and accessories with day labor under the direct supervision of the engineer. The excavation, backfilling and laying of sewer pipe and building of manholes were let out by contract on a unit price basis. A special form of accounting was developed whereby all proposals for supplying material, labor, etc., were entered in a loose-leaf booking system with special stationery. All payments made are shown on orders. The book includes a list of checks and each check is referred to a given order which explains every payment made. The file also includes copies of essential correspondence. The complete file, when turned over to the committee, will thus indicate all the steps in the process of construction, and it is so indexed that those interested can quickly go over the whole matter for their own information. As the borough will eventually buy out the present investors this special method of bookkeeping was devised for the benefit of a borough auditing committee and for any taxpayer who might be interested in the items making up the total cost of work.

The sewer system receives about 40,000 gal. of tannery wastes and 15,000 gal. of creamery wastes per day, together with the domestic sewage. The tannery wastes add a strong color to the sewage but by dilution and sedimentation, and apparently some precipitation, the original black color of the tannery wastes is converted into a yellowish tinge as the sewage leaves the outfall sewer. Two hundred feet from the submerged outlet of the outfall sewer this color disappears, even when the stream is clear. When the stream is turbid or colored with organic matter the point of discharge of the outfall sewer can hardly be seen. The effects of dilution and some precipitation can be noted in the sewer system itself as the tannery wastes become thoroughly mixed with the sewage and other wastes.

At present the Imhoff tank affords a detention for maximum flows of about 3.5 hr. The effluent is very free from suspended matter, though the tannery waste color is still apparent. The inlet and outlet manholes of the Imhoff tank are located at its mid-length and hence equidistant from the ends of the tank and its longitudinal axis is at right angles to the line of the trunk sewer and outfall sewer. This arrangement does away with the usual troubles experienced in the process of changing the direction of flow in the tank. The water depth of this tank is 17 ft.

PRECIPITATION IN OUTFALL

The outfall sewer consists of an 18-in. line about 400 ft. long, which is flooded to three-fourths of its depth. After the plant had been in operation for about six weeks a very considerable precipitation was noted in this outfall sewer, this precipitate being turned black by the tannery wastes. The precipitate formed as a result of the interaction of the tannery wastes, creamery wastes and sewage and has thus far aided in reducing the color of the final effluent.

The sludge bed is of usual construction. The tank sludge is pitch black in color and very finely divided; thus far no gaseous action has taken place. The vent compartments of the Imhoff tank are practically free from scum, and the flow compartments are absolutely clear of any floating matter, after two months operation.

FINANCIAL STATUS OF PROJECT

The total cost of the complete installation, including charges for land, rights of way, legal expenses, printing, engineering expenses for design and supervision of construction, together with the interest to date on capital during construction and an allowance for extensions will amount to about $25,000. The capital for the work was subscribed by private individuals, who, according to their subscription contract, are to receive 5 per cent on money invested. This 5 per cent is paid to the investor by the borough as a rental for the entire system. The borough maintains the system, makes all collections, etc., while the individual property owner leases from the borough the right to make a connection to the sewer. The complete scheme of contracts between the borough, the investor and the user of the system were fully detailed in the former article on the project, referred to previously.

The cost of maintenance of the system will amount to about $150 per year. The present street commissioner will have charge of the sewer system, and the principal maintenance charge will be the cost of hypochlorite of lime for the dosing of the tank effluent. Collections and rentals of the system will be in charge of the borough clerk, as a part of his general duties.

A $10 fee is charged for the ordinary house connection. The cost to hotels, factories, railroad station, etc., ranges from $25 to $150. The total assured income at present is $1,800, representing about 100 house connections. Additional house connections, however, are being rapidly made, and it will be safe to say that the average total income from the system for the next 20 yr. will be at least $2,000. This revenue from the system can be used only for payment, to the investors, of the 5 per cent on cost and for maintenance and purchasing investors' interests in the ownership of the system.

The financial status of the scheme may be briefly summarized as follows:

STATEMENT OF FINANCES

Approximate cost of system	$25,000	
Average revenue		$2,000
Borough rental at 5 per cent of cost.	$1,250	
Maintenance	150	
Total charges		1,400
Net revenue		$600

Allowing for interest on this yearly net revenue of $600 at 5 per cent, or the purchase of individual interests from year to year, which thereby reduces the rental, the proposition will show a balance of $18,600, in a period of 20 yr. At the end of the 20-yr. period, the borough could then purchase the entire system by bond issue, if it so desired, for the sum of $6,400. The above statement is conservative, since any public utility of this sort is unexpectedly used, and an additional revenue may be expected or the individual rentals reduced.

Cedar Logs in Good Condition After 55-Year Service in Dam

IN CONSTRUCTING the Strawberry rock-fill dam on the Stanislaus River in California it was recently necessary to remove a timber dam built by a mining company in 1861. After that part of the old structure which had been exposed to the action of the weather had been removed, the underlying cedar logs, which were from 3 to 4 ft. in diameter, were found to be sound and apparently in an excellent state of preservation. The surface of the timbers in some instances was slightly softened, but below a depth of about ½ in. the grain was as firm as that of freshly seasoned timber.

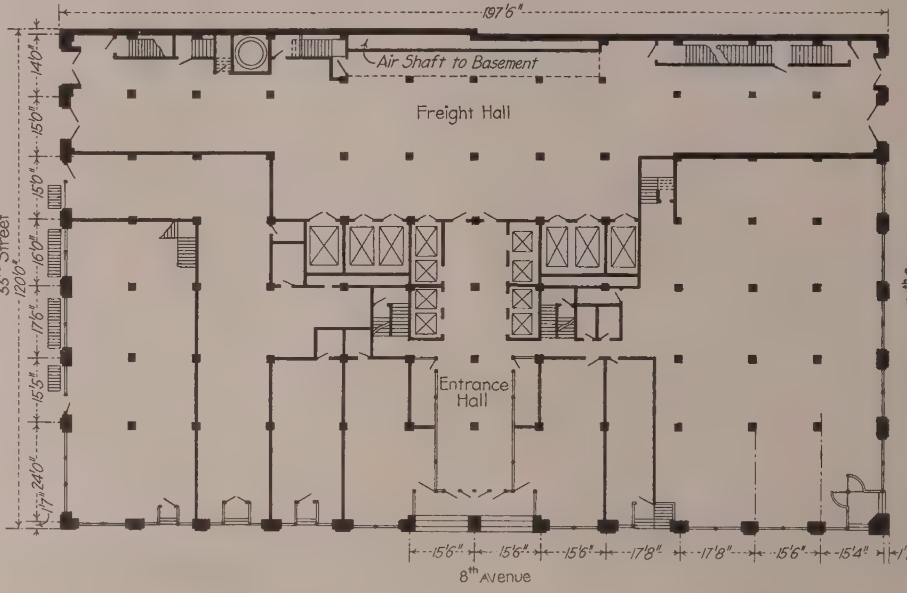
A FOUR-TON CLOCK WHEEL about 20 ft. in diameter was recently conveyed on an auto truck to the summit of Mount Wilson (Cal.) for use in the Carnegie observatory. The wheel, which is for driving the 100-in. telescope, will be attached to a solid steel shaft nearly 2 ft. in diameter, which will revolve with the exact speed of the earth, but in the opposite direction. The wheel was carried up the mountain in two pieces over a road 9 miles long with an average grade of 10 per cent and a maximum grade of 19 per cent.

Steel Frame of Printing Crafts Building Designed to Prevent Vibration

Heavy Modern Printing Presses Can Be Placed on Any Floor of New Building Now Being Erected in New York City

EVIDENCE of the shifting of business centers in New York City is furnished by the present active construction of a new twenty-two-story building at the corner of Eighth Avenue and Thirty-fourth Street. This building, called the Printing Crafts Building, is to be used almost exclusively for printing and allied trades, and marks the movement which has been active during the past ten years in changing the printing center from the old "Newspaper Row" to uptown New York in the vicinity of the new post-office building.

As ordinary office buildings are totally unfit to withstand the constant vibration and jarring due to the operation of heavy printing presses, it is necessary to design a building which is to be used for this purpose with special provisions against vibration. In addition, the necessity for maintaining relatively high temperatures in order to keep the ink in the requisite condition makes imperative an unusually efficient heating system, with reserve boilers sufficient to guarantee continuous operation. The danger from fires among the great quantities of paper is of such serious importance that fire-resistive construction with full sprinkler protection is a necessity. This new building is to contain all these features.



FIRST-FLOOR PLAN OF NEW PRINTING CRAFTS BUILDING IN NEW YORK

GOVERNING REQUIREMENTS

The new building is situated on a nearly rectangular lot, running for the whole block length between Thirty-third and Thirty-fourth Streets on Eight Avenue, with dimensions of about 120 x 197½ ft. Much blasting at this location, where rock is found near the surface, was necessary for the basement, which is about 20 ft. below the sidewalk and covers the entire lot. A mezzanine basement floor is used. The column foundations are ordinary rectangular piers of concrete on solid rock.

All the story heights are 14 ft. except the first, which is 22 ft. and a mezzanine floor in the rear, and the seventeenth, which is 15 ft. 10 in. Solid fire-resistant walls of terra cotta and brick are used for the two fire towers on the west side and a safety zone in the center of the building, where the seven passenger elevators and seven combination passenger and freight elevators are located.

As shown on the first-floor plan, the width of the building, which runs approximately east and west, is divided into panels of about 15 ft., with the exception of the 24-ft. front panel, while the length is divided into bays of unequal length, with four panels 17 ft. 8 in. to allow the use of exceptionally wide presses. It is planned to place the presses with their main axes east and west, and as vibration and wind stresses both will be greater in that direction, the columns are placed with their webs east and west, thus giving greater resistance and stiffness for the knee braces and brackets connecting to the heavier main girder beams between the columns.

FULL LIVE LOAD ASSUMED ON COLUMNS

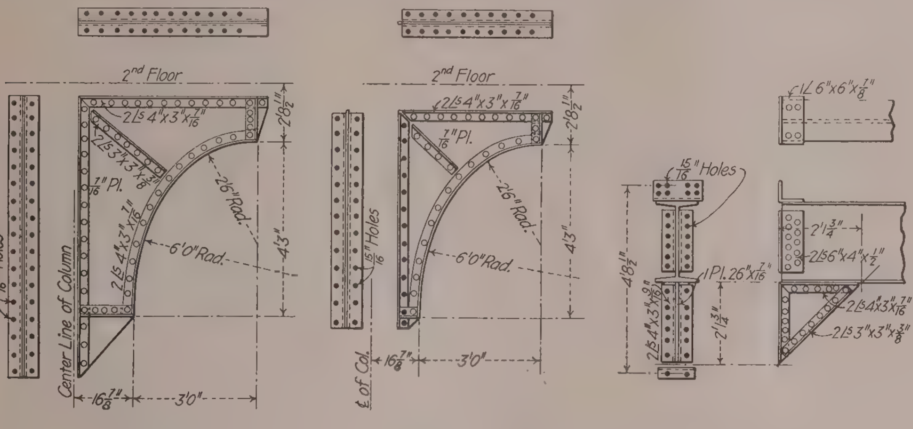
All floors are designed of steel beams and reinforced-concrete floor slabs to carry a live load of 240 lb. per square foot, using the usual types of reinforcement and details, with two lines of ¾-in. tie rods between the steel beams, the latter spaced from 5 to 6 ft. apart. The columns are designed to support the total live load on all floors from the top down, without any reduction.

The allowable unit stresses are the usual values specified in the New York building code. The columns are of Bethlehem H-section, reinforced by enough plates to provide the varying required sectional area. Splice plates having an exceptionally large number of rivets are used.

BRACKETS TO PREVENT VIBRATION

Above the tenth floor the typical knee brace used in both directions at each column consists of two angles 4 x 3 x ⅜ in. at a 45-deg. slope and extending 2 ft. out on the beams. Below the tenth floor the typical brackets are as shown in the accompanying diagram. Special curved brackets are placed in the high first story below the second floor in both directions at all columns. For the wall columns the brackets are placed above instead of below the beams whenever they interfere with the windows.

Heavy top connection angles and standard-angle web connections are used for stiffness. In the north-and-south direction, where connections are made to the webs of the columns, the brackets connect to the ordinary floorbeams. These beams between the columns have been increased in depth for the purpose of increasing the stiffness and resistance to vibration. The building is so long in this direction that the wind stresses are relatively insignificant.



Connection to Web Connection to Flange

TYPICAL BRACKETS FOR FIRST STORY

Connection to Flange

TYPICAL BRACKET BELOW TENTH FLOOR

DETAILS OF TYPICAL BRACKETS AND CONNECTIONS IN PRINTING CRAFTS BUILDING

DETAILS OF FINISH

The building is to be finished in rough gray stone with terra-cotta trimmings up to the fourth floor, and above this with plain gray brick carried on the steel frame. An effective band course of terra cotta at the seventeenth floor and pilasters extending from the seventeenth to the twentieth floors add to the architectural appearance, which is further enhanced by making the walls of the corner panels project beyond the walls of the interior panels, and by ornamental cornices at the roof. All windows are movable, with wire glass in the upper sash.

The building was designed by Edward L. Larkin, architect and engineer, and Frank J. McCabe, structural engineer, both of New York City. The owners and builders are the 461-Eighth-Avenue Company, which is erecting the steel frame. The contract for the steel was let to the Bethlehem Steel Company, which sublet the fabrication to the Hay Foundry & Iron Works of Newark, N. J.

THE ESTIMATED COST of the reservoir, dam and tunnel to be constructed in connection with the proposed new water supply for the city of Providence, R. I., is $12,000,000. The reservoir and dam will cover approximately 6 square miles and have a watershed of 92 square miles. The tunnel will be 6 miles long. This system, which will furnish a daily supply of 85,000,000 gal. of water, will do away with the present system of pumping water from the polluted Pawtuxet River. From five to seven years will be required to complete the work.

Requirements for Acceptance of Concrete Aggregates Based Upon Standard Tests

Materials Testing Division of New York Public Service Commission Develops Methods for Continuous Sampling and Testing of Concrete

STANDARD METHODS for the continuous testing of the aggregates and concrete used on the many contracts for New York City subway and rapid-transit railroad construction work, referred to in a previous article in the Engineering Record of Sept. 4, 1915, page 296, have been developed by the engineers of the Materials Testing Division of the Public Service Commission for the First District, New York, for all work under its supervision. These standard-practice instructions are believed to be of sufficiently distinctive character to justify reproduction of the more important details. In addition, the requirements or specifications for both fine and coarse aggregate as proposed and used for acceptance or rejection by the Materials Testing Division are here given.

In order to insure uniform results and scientific exactness in procedure, standard methods for testing and sampling have been adopted, and definite instructions issued. The concrete section of the Materials Testing Division provides inspectors at the plants whence the concrete aggregates are shipped to the works, and it tests these materials at a laboratory used exclusively for tests of concrete and concrete aggregates, the cement being tested elsewhere.

In addition to laboratory tests of fine and coarse aggregates, field specimens from the concrete as it goes into the structures and check laboratory specimens are made and tested. Special tests to assist in writing specifications are often necessary. The equipment and general arrangement of the laboratory have been adopted for efficiency of operation and economy in cost. The accompanying photographs illustrate some of the special features. The 2-in. molds shown are much cheaper than the usual form.

The permeability apparatus is unusually simple, being constructed by a plumber from standard supplies. The pressure in the tank is supplied by an ordinary automobile tire pump. The 4 x 11-in. pipe flanges with rubber gaskets 1-in. thick and 4-in. inside diameter effectively hold the specimen under test.

A chronological system of filing 3 x 5-in. cards is used to keep track of specimens and the time for testing. Printed blanks are furnished for each test to insure accurate, complete and uniform records.

TESTS OF FINE AGGREGATES

Complete tests of a fine aggregate comprise: (1) Determination of per cent retained on No. 4 square-hole sieve, (2) mechanical analysis of portion passing No. 4

VIEW OF TESTING LABORATORY—MOLDS SHOWN ARE CHEAPER THAN USUAL FORM square-hole sieve, (3) determination of silt by washing on No. 100 sieve, (4) determination of silt by decantation, (5) compressive tests of 2-in. cubes, (6) microscopical examination, (7) weight per cubic foot, (8) voids, (9) specific gravity, (10) reaction to litmus, (11) quantitative test for organic matter as indicated by loss on ignition, (12) density in mortar, (13) determination of insoluble silica.

It is usually necessary to make only the first six of these tests, and frequently only one or two are required. Extracts from the instructions for making tests 3, 4 and 5 follow:

(3) Silt by Washing on No. 100 Sieve

Separate 220 grams of moist sand by quartering and dry it at a temperature low enough to avoid baking any clay or similar matter, which would thus be rendered incapable of passing the sieve. If time permits, dry it at room temperature by spreading on a plate of glass. Use 200 grams of dry sand for the test. Extra care must be taken in dividing dry aggregate to prevent separation of fine from coarse.

After weighing allow the material to soak in water for a few minutes in order to soften hard lumps. Wash very thoroughly under a gentle stream of water (a violent stream would injure the sieve) and dry under a gas burner. Be extremely careful to avoid heating the sieve to a high temperature, which would melt the solder holding the sieve cloth to the frame. When dry weigh the residue on the sieve. The percentage of silt is the loss of weight multiplied by 100, divided by 200. State result clearly on report.

(4) Silt Determination by Decantation

Using two or more 100-cu. cm. glass cylinders graduated to 0.5 cu. cm.:

1. Take a fair sample of the sand to be tested by mixing portions from different parts of the pile. Mix thoroughly and spread out into a flat heap. Take opposite quarters of the heap, mix and spread as before. Repeat until the original sample is reduced to a small quantity.
2. Take approximately 20 cu. cm. of the small sample in one of the graduated cylinders. Add approximately 30 cu. cm. of lukewarm water and stir with a wire for 30 sec.
3. Allow to settle for 30 sec. Then decant the water into an empty cylinder, stir up the sand left in the bottom of the first cylinder with a fresh portion of water and repeat. Do this four times, then place the two cylinders on a level surface for 1 hr.
5. At the end of 1 hr. record the height of silt and sand which has settled to the bottom of the cylinders.
6. Compute the per cent of silt as in Table 1.

TABLE 1—SILT DETERMINATION—SAND SAMPLE 45

Route 2, Section 20, P. Smith Contracting Company. From subway excavation at Eighty-first Street. Sampled by J. Jones. Remarks: This sand is being stored at Eighty-third Street for future use. Tested by J. Jones.

19.0 cu.cm. = volume of clean sand remaining in cylinder 1
4.2 cu.cm. = volume of silt in cylinder 2
23.2 cu. cm. = total volume
18 = per cent of silt = 4.2 × 100 ÷ 23.2

A number of independent tests should be made and the average value used. This test is for field use only.

(5) Compression Tests of 2-in. Cubes

Use the methods recommended by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, except where the following instructions require otherwise.

To avoid the removal of any coating on the grains, which may affect the strength, fine aggregate must not be dried before being made into mortar, but must contain natural moisture. The percentage of moisture may be determined on a separate sample for correcting the weight. The weight of moisture is counted as a part of the water used for mixing and not as a part of the weight of the sand.

Proportions are to be 1 : 3 by weight. Since the sand is weighed in a moist condition the actual weight will be three times the weight of cement plus the moisture contained. The cement should be screened through a No. 30 sieve and then worked over dry with a trowel to break up any remaining lumps.

Special Consistency Specified

Mortar is to be made of the same consistency as that of Ottawa sand mortar when mixed with 60 per cent of water above what is required for normal consistency; that is, if 10 per cent of water is required to make Ottawa sand mortar of normal consistency, then 16 per cent of water will be required to make Ottawa sand mortar of Public Service Commission consistency.

Since the amount of water necessary to give a particular consistency varies with different aggregates, the only known way to determine the correct amount of water to use is experimentation. The temperature of the gage water must be about 70 deg. Fahr. Mortar must be mixed hard with the hands for the time specified and thoroughly worked into the molds with the hands and trowel.

Ten specimens are to be made in each test, to be broken as follows: Four after 3 days, three after 7 days, and three after 28 days. Three-day specimens must be tested within one or two hours of the correct time. Ottawa sand specimens of the same consistency are to be made with each test.

Specimens which vary in weight more than 3 per cent from the average should be rejected.

No tensile tests are required, because it is believed that comprehensive tests more nearly represent working conditions.

Tests of Coarse Aggregates

Complete tests of a coarse aggregate include: (1) Mechanical analysis, (2) cleanliness, (3) weight per cubic foot, (4) voids, (5) specific gravity, (6) crushing strength. It is usually necessary to make only the first two of the tests, the instructions for which are as follows:

Ordinarily for the mechanical analysis use a 25-lb. sample reduced from a larger sample, if necessary, by quartering. Carelessness in selecting or dividing the sample makes the test worthless. If necessary to use a smaller sample, use as large a one as possible, the results being easily reduced by slide rule. Screen in rocker 100 bumps (50-cycles), using 2-in., 1½-in., ¾-in., ½-in. and ¼-in. screens. Weigh residue on each sieve and record in regular record blank. Record also the weight of the sample used. This will give a permanent record of the accuracy of the test. The sum of weights retained on the different screens, together with the weight passing the ¼-in. screen should equal the weight of the sample used. If a large sample is used some of the screens will be found to be overloaded. The material on these must then be divided and rescreened in such a way as to give correct results.

Cleanliness is judged by inspection only.

Field Samples of Concrete

In taking samples of field concrete for compressive tests, the large standard molds, 8 x 16-in. iron pipe (described in the article of Sept. 4, 1915) should be used. A smaller size is too small for coarse aggregates. If the edges do not register accurately when the bolts are tightened, try changing the position of the straps. Iron molds are oiled with heavy machine oil. Set the molds on level iron plates, also oiled. It is not well to set them on a piece of board, because it may be warped and permit leakage from the specimen. Place sand or mud around the bottom of the mold to prevent leakage.

Concrete for the specimens should be taken directly from the forms at a place where it has been rammed or spaded to its final condition. A fairer sample can be obtained after the concrete is spaded than before. Great care must be used to take an average sample. The molds should be placed as near the forms as possible in order to avoid separation of coarse aggregate from the concrete during transportation. In order to overcome the effects of such separation as may be unavoidable, distribute each pailful of concrete to several specimens. A little care in finishing the top surfaces of specimens will save much trouble when they are tested. If the concrete is very wet it will shrink and expel water after standing. The ends of such specimens may be finished with dry sand and cement after standing for a few minutes.

If there is danger of the specimens being dishonestly tampered with, place a small piece of paper on the bottom of the molds for identification. The molds are filled in not less than three layers, each layer being worked well with a trowel to remove air bubbles. Each test consists of six specimens, three to be broken 28 days after mixing and three to be broken 90 days after mixing.

Samples of Aggregates—Storage

Obtain a 25-lb. average sample of coarse aggregate and 3 qt. of fine aggregate to be tested in the laboratory. Record the make of mixer used and be particular to give correct consistency, since the consistency largely affects the strength. The following terms describe consistency: Dry, medium, wet, very wet and extra wet.

Specimens are left on the work two days and are then brought to the moist room before the molds are removed. In the moist room remove the molds and paint on the cylinder the contractor's initials, test number and specimen number. Specimens are stored in the moist room and sprinkled daily with the hose until two days before being tested. Two days before breaking each set send a standard notice to the section engineer concerned. Specimens must be removed from the moist room to the laboratory two days before breaking in order that they may become dry.

Methods Used in Testing Cylinders

A specimen whose ends are planes and fairly smooth need not be plastered. The ends of all specimens not plastered are to be cushioned against plain board, compo-board or some similar material. This should be turned over after each test in order that the dented side may not be next to the specimen. Soft material, like sheet lead or felt, must not be used, because it will spread laterally and split the specimen. If difficulty is had with other materials on this account it is possible that a piece of tin inserted between the specimen and the cushion may be of advantage. Further experiment in this direction is desirable.

The manner in which a specimen breaks indicates the character of its end bearings. The first cracks should appear in the middle (not at the ends), and the ends should remain intact after the specimen has failed. Avoid coming down on the specimen at fast speed with a shock or jar. Use the medium-speed or the low-speed gear for testing. The report of the test will not be very valuable unless the operator is alert to note and report important details. Notes such as the following greatly increase the value of the report:

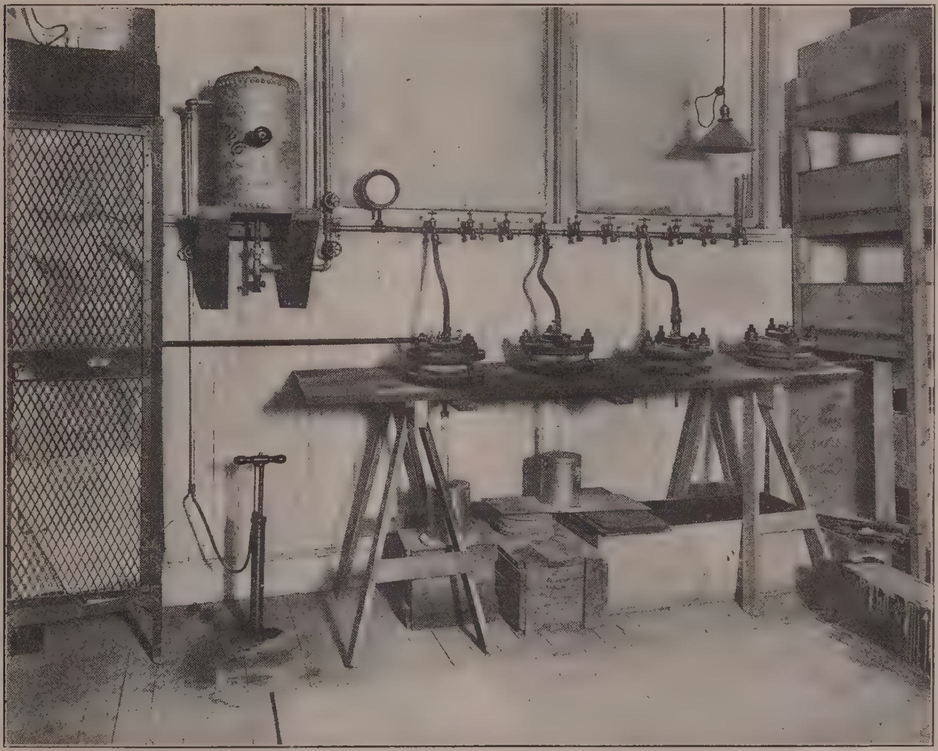
Specimen No. 2 had excess of stone at center. Concrete so wet that a fair sample could not be obtained.

Gravel sheared in specimen No. 3.

Mortar not bonded to coarse aggregate. Latter appears as if stones were surrounded with film of water during hardening of concrete.

Extreme cold injured specimens while stored on the work.

Gravel used contained considerable sand.



PERMEABILITY APPARATUS CONSTRUCTED BY PLUMBER FROM STANDARD SUPPLIES

A daily record of outdoor temperature should be kept in order that the cause of variations due to extremes of temperature may be known.

PERMEABILITY SPECIMENS

Mix the mortar according to directions accompanying the waterproofing compound which is to be tested. Make several specimens to be tested after 7 days and several more to be tested after 28 days. In no case make fewer than eight treated specimens and eight untreated specimens for comparison. Use extra clean, coarse sand (not Ottawa sand) for these specimens in order that the waterproofing compound may receive no assistance from silt in the sand. In the absence of different directions mix the mortar to the same consistency as herein specified for 2-in. cubes. Place the mortar in the 8-in. pipe sections in the same way as specified for the cubes. Specimens are to be ½ in. thick unless otherwise noted. The iron plates under specimens must be thoroughly greased. Strike off tops of specimens with a straight edge.

Store the specimens in moist air 24 hr., then brush both surfaces with a wire brush, mark and place in water until tested. Paint must not be placed on the surfaces which are to be tested. The specimen is not removed from the mold until after it has been tested. Upon removing specimens from the water, brush both surfaces again with a wire brush. Test under a pressure of 50 lb. per square inch for at least 7 hr. Some means must be used to prevent water from the outside from leaking into the measuring glass, since it has a tendency to follow down the outside of the outlet pipe.

Record results at 15-min. intervals. On the report show time elapsed from application of pressure to first leakage, average leakage for the time after specimen began to leak, and maximum leakage for one hour. Express results in cubic centimeters per square foot per hour.

REQUIREMENTS FOR FINE AGGREGATE

The specifications in the contracts for fine aggregate require "clean sand approved by the engineer." In order to reduce inspection to a definite standard the Division of Materials Inspection proposes that fine aggregate for concrete shall conform to the requirements in Table 2.

TABLE 2—MECHANICAL GRADING LIMITS—FINE AGGREGATE

Size of opening. (Square holes.)	Commercial number of sieve.	Limit of fineness (per cent passing). Not more may pass.	Limit of coarseness (per cent passing). Not less must pass.
0.20	4	100	95
0.10	8	95	85
0.042	16	75	40
0.021	30	50	20
0.011	50	30	2
0.006	100	6	..

Not over 6 per cent dry weight shall pass a No. 100 sieve when screened dry. Not over 10 per cent dry weight shall pass a No. 100 sieve when washed on the sieve with a stream of water. Both of the above tests shall be made and neither limit shall be exceeded.

The following test is for field use only: Not over 10 per cent by volume shall be silt when the test is made by decanting from test tubes, as previously described in standard-practice test 4 of fine aggregate.

Fine aggregate shall be of such quality that mortar composed of one part Portland cement and three parts fine aggregate by weight will show a tensile and compressive strength at least equal to the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand. Fine aggregate shall not be dried before being made into mortar, but shall contain natural moisture.

Loss on ignition shall not exceed 0.1 per cent of the total dry sand by weight, nor 10 per cent of the silt obtained by decantation, as described in standard-practice instructions previously given.

REQUIREMENTS FOR COARSE AGGREGATE

Coarse aggregate for concrete shall conform to the requirements in Table 3.

TABLE 3—MECHANICAL GRADING LIMITS—COARSE AGGREGATE

Size of opening (square holes), in.	Limit of fineness (per cent passing). Not more may pass.	Limit of coarseness (percent passing). Not less must pass
2	...	100
1½	100	95
1	80	40
¾	60	25
½	40	10
¼	5	..

All broken stone aggregates must be so free from dust that samples caught as the material falls from the conveyor belt at the plant will be within the limit of fineness. All gravel must be thoroughly washed at the plant.

FIXING LIMITS FOR MECHANICAL GRADING

In deciding upon the limits specified in the mechanical grading of sand, the limits of fineness were modified from those given by various authorities to give a curve of the same general shape as the curve for maximum density. The object was to obtain a sand whose strength will equal that of Ottawa sand in mortar. The limit of coarseness was prescribed because a very coarse sand tends to produce a mortar which is not cohesive enough to prevent the separation of coarse aggregates. The values given are based on experiments, but are not considered to be exact enough to use as rigid requirements.

The limit for maximum size of coarse aggregates is fixed in the specifications at 1¾ in. The values given above are based on the assumption that ideal grading is a straight-line variation from maximum size of sand to maximum size of stone, as shown by experiment. Variations are permitted in order to meet practical conditions.

Alfred Craven is chief engineer, Robert Ridgway is engineer of subway construction and George L. Lucas is general inspector of materials for the New York Public Service Commission. R. E. Goodwin, who furnished the foregoing data, is in charge of the tests of concrete and concrete aggregates.

Dual Type of Brick Paving Aids Traffic on Grades

Smooth and Hillside Brick Sections on Same Street in Oakwood, Ohio, Accommodate Horses and Motors

BY USING two types of brick paving on a single street with a 4 per cent grade in Oakwood, a residential suburb of Dayton, Ohio, slow and fast-moving traffic has been automatically separated, wear distributed uniformly from curb to curb, horses provided with a secure footing on both uphill and downhill slopes, and accidents due to slipping of animals or skidding of vehicles practically eliminated. Farhills Avenue was one of the thoroughfares selected by K. B. Allen, city engineer, for the dual type of surfacing. The central trafficway is 18 ft. wide and is paved with standard wire-cut lug brick; the flanking routes are each 11 ft. wide and are surfaced with hillside brick, which, with its specially designed grooves, allows horses to haul loads up and down grade without danger of falling. This plan also was carried out on 30-ft. streets with an $8\frac{1}{2}$-ft. hillside brick surfacing along each curb and a 13-ft. smooth roadway in the center.

Three Gangs Work Together

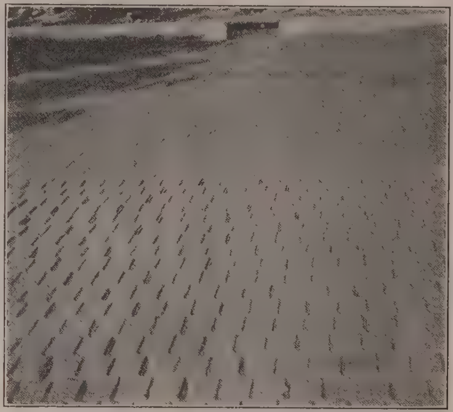
Considerable opposition to this type of construction developed on account of its novelty, and because the contractor and others assumed that the laying of the two kinds of pavement together would entail extra work and present costly constructional problems. Mr. Allen was confident, however, and the work began. Within a very short time the contractor confessed his entire conversion to the new plan. Three paving gangs could work at the same time. The sidehill brick, being laid longitudinally and not requiring batting, progressed faster than the center, in which the brick were laid transversely. Thus the hillside brick work was kept out of the way of the center gang, which had to bat the transverse courses in closing up the courses where they joined the hillside stretches. The batting was of the same nature as if it had been done against the curb, and it would have been necessary in any case.

Sometimes only two gangs of pavers were at work, but as the gang working on the hillside stretch made more rapid progress than did the men working on the smooth section it was possible to transfer the former from one side of the street to the corresponding hillside stretch on the opposite side, thereby expediting construction and keeping all hands busy all the time.

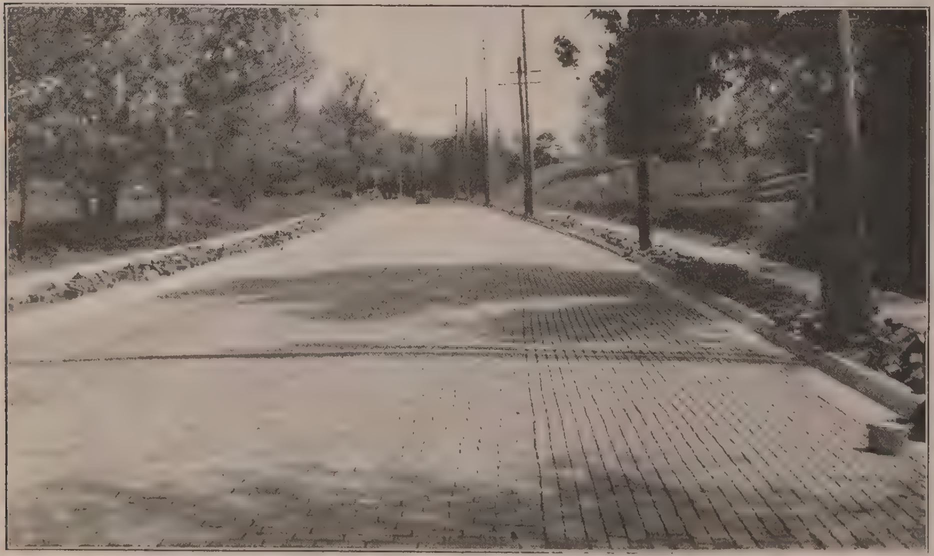
It was possible to lay the brick on the entire roadway in one-half the time, or one-third of the time, required for an ordinary brick pavement, because two or three separate gangs could be worked simultaneously.

Grouting

In grouting this type of pavement the usual practice was followed on all sections, but in removing the surplus grout from the transverse grooves of the hillside brick the grout was swept from the grooves before it had attained its initial set, and just as it began to reach the thickening stage. By doing the sweeping at that stage the grout was removed from the grooves easily and completely.


FINISHED BRICK PAVEMENT WITH DUAL SURFACING IN OAKWOOD, OHIO

There has been laid in Oakwood 27,000 sq. yd. or 8000 lin. ft. of this type of brick pavement, using wire-cut lug brick made by the Hocking Valley Brick Company of Columbus, Ohio. Horse-drawn vehicles ascend the grade on one side of the street and descend on the other side, while motor vehicles keep to the smooth center. Thus, not only is traffic distributed so that all parts of the pavement, from curb to curb, are in constant use, but congestion of traffic is prevented. After two or three trips over the pavement, horses voluntarily seek the hillside stretches, and remain there, going easily up one side without slipping and trotting confidently down on the other side. Teams that are driven on the smooth central stretch as a test immediately swing over to the hillside brick for a secure footing. Thus, there are four separate and distinct lines of travel on these streets, the middle stretch being of ample width for ascending and descending auto traffic, and the sides dividing traffic between upgoing and downgoing horse-vehicle traffic.


STANDARD BRICK ALONG CENTER OF STREET FOR MOTOR TRAFFIC AND GROOVED HILLSIDE BRICK AT SIDES FOR HORSES; VIEW TAKEN PRIOR TO GROUTING THE PAVEMENT

HILLSIDE BRICK STRIPS WERE LAID FASTER THAN PLAIN BRICK

Advantages of Smooth and Rough Surfaces on Same Street

The practical advantages of this type of surfacing have diverted traffic from a paralleling smooth brick pavement on a grade street which runs into the same loop with which the new pavement connects. The result has been a cessation of complaints arising from minor accidents caused by horses slipping and vehicles skidding on steep grades in bad weather.

Experience has shown that autos do not skid on the new pavement, either in wet weather or in the winter season. In the worst weather, it is claimed, autos can run over the hillside brick stretch with safety, nor do the transverse grooves of the hillside brick cause any inconvenience, as the grooves are so broken up that while a horse can readily find a grip for his toe calks, a broad tire runs over the pavement on a plane surface, without jolting.

Another reason, on streets occupied by traction lines the hillside brick keep horse-drawn vehicles off the car tracks. On grades, smooth wire-cut lug brick are used between car tracks and for 10 in. each side. The remainder of the street is laid with hillside brick. Actual service has shown that teams keep off the car tracks and walk right up the hillside brick stretches. There is no stopping to rest teams and no trouble in starting with loads, as the horses are sure of a foothold.

The specifications for the paving provided for a 6-in. concrete foundation, 1:3:6 mixture, a $1\frac{1}{2}$-in. sand cushion, and a cement grout filler, 1 to 1 mixture, of cement and sand.

The work was done by Bigler Brothers, contractors, of Dayton.

THE COST OF POLICING New York City's Catskill Aqueduct during the course of construction amounted to $1,995,050.28 at the end of the year 1914. The police bureau was not organized until 1908, while the project was started in 1905. The sum spent on policing amounts to more than 1.6 per cent of the total money spent on the additional water supply project to the end of 1914.

Shore at Venice, California, Best Protected by Permanent Sea Wall and Low Groins

Report of Leeds & Barnard Discusses Coast Preservation Fully—Defective Bulkheads, as Well as Piers and Other Obstructions, Cause Damage

IN A REPORT on the best means of protecting the ocean front at Venice, Cal., against the action of the elements, the investigating engineers, Leeds & Barnard, of Los Angeles, have given an extensive discussion of the principal forms of protection. They hold that defective bulkheads themselves may contribute to erosion, while projecting piers and other obstructions, by arresting accretion that might otherwise replace the erosion. They advocate durable sea walls and long low groins for Venice, where the attractive beach is a valuable asset to the city, where breakwaters would destroy the beauty of the surf, and where high groins would break up the continuity of the beach. They emphasize the importance of proper design of the wall, with a curved and slightly overhanging outer face to turn the waves gradually and keep them from breaking over the wall, and a wide apron so that the returning waves will fall on the apron and not on the erodible beach in front of it. Following is a presentation of the report in somewhat curtailed form.

The damage to the waterfront in the city of Venice wrought by high tides, combined with storm conditions, and for which it is the purpose of this report to recommend measures of repair and future prevention, consists of two principal kinds—particular physical damage to abutting property, and general damage to the valuable reputation of the whole city as a seaside resort.

The immediate damage to property fronting on the beach is too fully appreciated and its amount and extent are too well realized by the owners to need any comment here. The future extent of this damage is impossible to estimate, unless an absolute protection from the direct action of the waves is devised, installed and maintained. The damage to the reputation of the city as a beach resort is less immediate in its consequence, but none the less real. It is evidenced by marked depreciation of high-priced beach-front property values, with corresponding depreciation of other city property values.

The physical damage done consists of the erosion of the bathing beach, the destruction of most of the concrete bulkhead and promenade, the partial or complete destruction of buildings and improvements, and the washing away of large parts of the lots between the ocean front and the Speedway.

CAUSES OF DAMAGE

Venice naturally has a smooth, gently curving beach, facing southwest. The prevailing swell in summer is from the west and northwest. At such times the beach builds naturally. In winter the heaviest storms come from the south and southwest, and it is the southwest storm waves in conjunction with high tides which seriously erode the beach. What are known as tide rips also occur at uncertain intervals and cause serious erosion.

The prime cause of this damage along the waterfront has been, of course, the combination of high tide and heavy seas described above. Several other causes, however, may have contributed to this, and will contribute to further damage, among which may be mentioned the following:

1. Bulkheads.
2. Piers and other artificial projections from the normal shore line.
3. The alignment and contour of the shore itself.
4. The nature of the material of which the coast consists.

BULKHEADS THEMSELVES CAUSE DAMAGE

These are in themselves a frequent and almost certain cause of damage to the beach, and agents of their own destruction, unless protected from the direct impact of the waves by a naturally or artificially maintained beach. During high tides and heavy on-shore gales, the waves strike the bulkhead and are suddenly stopped in their course. A large volume of water is thrown upward to a height depending on the depth of the water in front of the bulkhead. This, in falling back, cuts out the beach, carrying away the loosened material with the return wave. The beach thus becomes lowered, the depth of the water is increased, and the volume and force of the waves are augmented as the storm continues.

The destructive effect of the waves is also increased by the large quantities of water which, driven by the on-shore wind, fall on the roadway or ground behind the bulkhead, and saturate the same. This water of saturation increases very largely the pressure against the back of the bulkhead, which has been already weakened by the removal of the sand from the seaward side thereof. In the case of non-watertight concrete sheet-pile bulkhead this water of saturation joins with the water which has been jetted through the openings in the bulkhead by the impact of the waves, and escaping through the same openings, carries away the sand from behind the bulkhead and under the promenade, causing the collapse of the whole structure.

PIERS AND OTHER ARTIFICIAL PROJECTIONS

The prevailing littoral drift of the sand along this shore is toward the south. When the beach is in its natural condition this drift is not evident, for what is eroded from one spot is replaced by other material from just northerly thereof. If, however, a slight obstruction be made, the sand will be accumulated on the northerly side of it. On the leeward or southerly side the sand travel continues, but is not replaced by other sand, and a depletion therefore results.

This sand movement is due to the combination of a number of forces. Each wave which strikes the beach at a slight angle carries some of the sand up the beach diagonally, dragging it straight down the beach again, to be again carried diagonally up the beach and be again dragged straight down the beach. Each particle thus progresses along the beach in a zig-zag fashion.

In addition to this there will be found intermittently a trough in the beach, parallel to the beach front and a short distance below low water line. The sand which is dragged down the beach by returning waves is carried along parallel to the beach in this trough by the littoral current. This trough is found only at certain times, and for this reason the littoral sand movement is not as pronounced here as in some places on the Atlantic seaboard, where such troughs are more continuous. This shows, however, how essential it is that any groins constructed should be carried out to a point beyond this trough, and must be especially strong at the outer end.

SAND EROSION AND ACCRETIONS

Wherever the waves are broken up and the water is quieted, this sand travel along the coast is interrupted, and an accretion of sand results. The more complete the interference, the greater will be the accretion. This may be seen in the shelter of every pier along this shore, the greater the number of piles or other obstructions, the more sand being collected.

When storms occur with a gale blowing from another quarter than that of the prevailing winds, the influence of the projections mentioned above is changed or even reversed, and where filling normally takes place, cutting results, and vice versa.

The effect of an outlying reef in shoal water can be seen in frequent instances by an inspection of the coast line. The action of such a rock or reef is to create a quiet area under the lee of the reef. The shore being protected from the waves (which form the principal factor in sand travel) there is no power to move the sand along, unless there be a strong current.

ALIGNMENT OF SHORE AND NATURE OF MATERIAL

The same processes mentioned above, as occasioned by artificial projections from the coast line, are also occasioned by certain sharper natural projections of the coast itself. In addition to this, submerged valleys and shoals influence the force and direction of shore currents and so affect the erosion and accretion of material making up the beach.

The nature of the material has much to do with the rate at which erosion may take place. In the case of steep sand beaches, material is cut away to depths of several feet over considerable stretches of beach, in a single storm. Where the beach is underlaid with clay or rock, it is often scoured to this substratum and further erosion is checked thereby.

The beach material along Santa Monica Bay is undoubtedly the result of the erosion of the cliffs to the northward, toward Point Dume.

PREVENTING OR REPAIRING DAMAGE

The approved methods of preventing or repairing coast damage are of four principal kinds: (1) Sea walls or bulkheads, parallel to the shore and situated about the high-water line, or even farther seaward, in the case of recovery or protection of streets or promenades; (2) groins, or projections across the beach from above high water to or below low water; (3) breakwaters or reefs, parallel to, and connected by spurs with the shore, and (4) beach revetment, or slope protection between high and low water.

The purpose of sea walls or bulkheads is to protect low-lying lands from erosion and inundation by the sea, to preserve the cliffs where land above is of sufficient value to warrant the cost of the protection, and, at seaside towns, to hold up the roads and

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promenades along the shore and protect them from damage by waves. The profile of the wall should be such that the waves will be reflected and not break directly against the wall. It should also guide the wave so that in returning it will not fall behind the wall or at its foot.

A sea wall, or bulkhead, should ordinarily be placed at or above the line of ordinary high water. On the other hand a properly designed and well constructed sea wall may, if the additional expense be justified, be placed seaward of this line in order to provide additional land behind the sea wall for roadways or promenades.

At Venice the line of normal high tide under existing conditions lies back of the line of the now destroyed concrete bulkhead. This condition must be recognized in planning any shore protection at this location.

SHAPE OF WALL IMPORTANT

A sea wall or bulkhead almost always induces scour at the toe. This is the more true the more nearly vertical the wall is. The waves strike the vertical wall with great force and throw great masses of water into the air, and this, falling at the toe of the wall, loosens and scours out the material, which is carried away by the waves. When the wall is inclined the force of the wave stroke is decreased. There is still a tendency to scour, however, from the back wash of the waves.

The top of the wall should have a slight coping to turn the wave seaward, rather than allow it to be thrown straight up and then be blown on to the promenade. The best form of sea wall is one which has a curved face. This, instead of opposing a flat perpendicular face to the direct impact of the wave, guides the wave from the beach to the wall in the easiest manner possible and rolls it upward and backward. The projection of the upper part should be only just sufficient to deflect the upward wave out from the wall. As the water falls it is received again on the curved face, which extends far enough to the front to prevent scour, and delivers the return wave parallel to the surface of the beach, without disturbing the same.

This necessity for an extension or apron in front of the wall is evident from the experience at numerous places, where subsequent to the construction of the sea wall, either groins or an apron had to be added to stop further scour.

Timber walls or bulkheads are used where a less expensive and more temporary construction is desired, because property values will not warrant a more expensive and permanent type, or in the absence of a determination of the final location of a permanent structure. Such timber bulkheads cannot be so constructed as to present as favorable a profile to the action of the waves as can sea walls, and are generally constructed in a nearly vertical position. Under such conditions they are not to be recommended even for temporary construction, except where the beach can be maintained reasonably close to its normal level. On the other hand, it must be admitted that the great resiliency of wooden construction in resisting wave impact is a strong argument in its favor.

PURPOSE OF GROINS

The purpose of groins is to build up a beach or maintain it at a given level by catching and holding the littoral drift. Groins are of three classes: (1) High, substantial groins placed at short intervals; (2) less expensive, low groins, rising only a short distance above the beach; (3) single, longer, permanent structures, to accumulate material over considerable length of coast.

High groins tend to bank the beach material high up on the windward side and leave it far below this height on the leeward side, thus offering considerable obstruction to travel along the beach. To build up a depleted beach uniformly without interfering too much with the use of the beach, low groins of the second class are more satisfactory. A jetty extending for several hundred feet out to sea constitutes a groin of the third class, and will tend to build up the beach for a considerable distance on its windward side. This is usually of more permanent construction.

PURPOSE OF BREAKWATERS

The purpose of parallel breakwaters, as their name indicates, is to break the force of the waves, producing comparatively quiet water between them and the shore. In order that these breakwaters shall not be undermined and damaged in heavy seas, they should be located at or seaward of the line of formation of breakers, as it is at this point that the sand movement due to wave action becomes considerable.

Beach revetment, which has been used to a great extent in Holland and elsewhere for the protection of embankments, consists simply in facing the slope with some form of wood, concrete or other protective material. Because of the flat slope necessarily given to this form of protection it occupies a great width of beach. For this reason, and because of its appearance, it is not believed suitable for use at Venice.

There may be numerous other devices which have been proposed for shore protection, but others than the ones above mentioned have not proved successful.

METHODS APPLICABLE AT VENICE

We will now consider the applicability to Venice conditions of the three types of protection (breakwaters, sea walls and groins). For convenience breakwaters will be considered first.

It may be stated in favor of breakwaters that if the interval between them is not too great in proportion to their length they would undoubtedly thoroughly protect the beach. The probability of the growth of the beach behind the breakwater is not so easy of determination, however. Breakwaters should be built of large random rock, laid on a mattress of smaller rock, with a wide base and slopes flat enough to give reasonable assurance of the stability of the structure. Too flat slopes will entail very great expense, whereas too steep slopes will result in the top being constantly damaged in storms, and extensive replacements will be made necessary.

Such a breakwater as is considered safe would have a top width of 10 ft., a slope of 1 on 2 on the sea side and a slope of 1 on 1½ on the land side. The top should be at least as high as a high-water level. A careful analysis shows that such a breakwater should cost in the vicinity of $120 per linear foot of breakwater, or $80 per front foot of the beach.

It must be foreseen that the benefit to be derived from protection by breakwaters would fall very unequally on the beach front. The sections of the shore directly behind the breakwaters would be much more protected than those directly behind the gaps between the breakwaters. Furthermore, the beauty of the waves breaking on the beach would be lost. Even with such protection some form of sea wall or bulkhead will be necessary to maintain the walk and property behind it. This would add probably $10 or $20 per linear foot of beach, making the total cost of such protection about $115 per front foot. Because of the expense, the inequality of the protection and the loss of the beauty of the surf this type of protection is not believed advisable.

GROINS

High, short groins we do not recommend in this case, as they obstruct the beach and would not be adequate in this location. Low groins are the most common type, and the best under conditions such as those at Venice, particularly where it is desired to interfere as little as possible with the use of the beach for bathing and pleasure. If properly designed and maintained there is little question of their success. The cost of these low groins should be about $2 per linear foot. As they are usually spaced at an interval of about twice their length their cost per front foot of beach protected should be about $1. Using creosoted material throughout would bring the cost up to about $1.50 per front foot of beach.

Long permanent groins are designed to cause the accumulation of beach material for a considerable distance. They should extend oceanward far enough to intercept all littoral drift. They should be located at intervals of about a third of a mile. In the absence of a survey below low water mark, it is believed that 400 ft. will be a sufficient length to intercept the littoral drift. This would make the cost approximately $2.50 per front foot of beach protected.

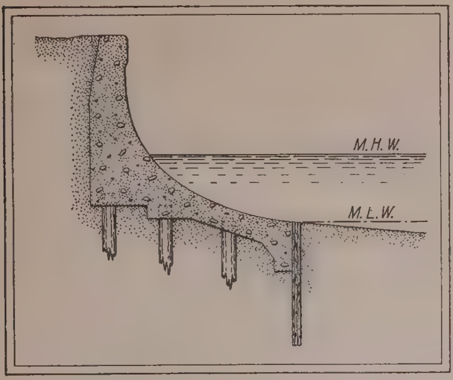
NEITHER GROINS NOR SEA WALLS ALONE ARE SUFFICIENT

Concerning sea walls and groins it should be understood that neither by itself alone is sufficient. A sea wall protects the ground back of it from destruction, but by the obstruction which it interposes to the waves always tends to lower the beach in front of it. By a proper design of its cross-section this tendency may be minimized, but a sea wall certainly will never build up a beach.

Groins, on the other hand, by arresting the littoral travel of the sand, tend to build up the beach and extend the same seaward. This cushion of sand collected in summer is, however, never sufficient of itself entirely to protect the shore against the inroads of the storms in winter.

The excellent beach at Venice with its beautiful surf is one of its greatest assets. Effort should therefore be made to protect it from further erosion and to extend it seaward. The present accumulation of sand northward from the Del Rey jetties shows what may be done. By the construction of other permanent groins northward, the beach may be built out progressively.

These groins must be long enough to cross the trough which intermittently forms parallel to the beach, and along which the greatest sand travel occurs. They should be constructed of rock, and thus will be secure against destruction from storms. The outer ends will be the most subject

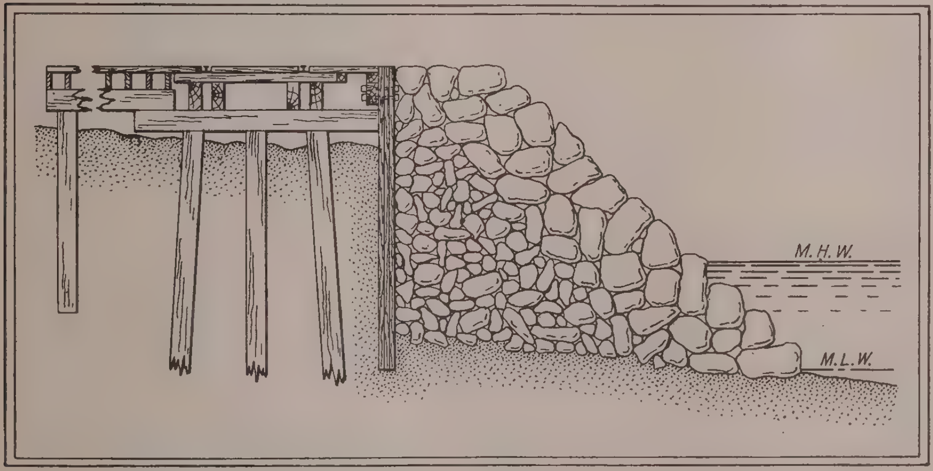


CONCRETE SEA WALL IS MOST DURABLE

to attack, and hence should be made stronger. Any tendency to scour under them will be promptly counteracted by the stone settling in place.

PROBABLY THREE OR FOUR GROINS ARE NEEDED

As they extend so far seaward, their influence will be correspondingly greater than shorter groins, the volume of sand collected will be greater and the distance between them can be much greater than with shorter groins. Consequently they will not disfigure the beach. The number necessary can be better determined after a detailed survey of the beach, but three or four will probably be sufficient. They should be low to allow the waves to pass over them.



RANDOM ROCK WALL IS EASILY REPAIRED BY REPLENISHMENT AT TOP AS BOTTOM SETTLES

The most southerly groin should be constructed first, and after the pocket formed by it has filled with sand, then the next, and so on. Otherwise the northerly groin will catch all the sand and those south thereof will be useless.

In order to afford early protection to the section previously damaged, however, it would probably be advisable to build first a short permanent groin at about the southerly limit of the beach erosion which took place in the storms of the last two winters. This can later be extended to a length equal to the others.

SEA WALL

To hold the shore line it is necessary to construct a sea wall. This is ordinarily placed at or above high water. Since the line which it is desired to hold at Venice is in some places seaward of high-water mark, it is the more necessary to construct a substantial sea wall, and this must be stronger in this location than if placed farther back.

It is good practice, wherever possible, to found the sea wall upon some solid material, such as clay, shale or hard pan. At Venice there is apparently no suitable foundation at an economical depth. Accordingly it is proposed to found the concrete sea wall on piles, as was done at Galveston. This will be amply strong. Should subsequent investigation show the existence of a good foundation at a less depth, the cost may be decreased. Sheet piling, which will be necessary during the construction, will be used as a form, and will then be simply sawed off at the toe. This will serve as an added safeguard against undercutting, should any unusual storm lower the beach level before the groins have had time to accumulate sand in front of the wall.

SHEET-PILE BULKHEADS INADEQUATE

The only safe shore protection is a wall on a sound foundation sufficient of its own weight to resist the onslaught of the waves. For this reason any form of sheet-pile bulkhead is believed adequate. Such a bulkhead must be absolutely watertight and be driven deep enough to be certain of not being underscoured. It should slope at least 45 deg. and should go several feet below low-water line. It will be noted that the concrete apron of the sea wall that is recommended extends 4 ft. below low-water line, exclusive of the sheet piling. The probable scour with an incline sheet-pile bulkhead would necessitate going deeper than that.

Another serious objection to concrete sheet piles is the abrasion during storms by the shingle or pebbles thrown up by the waves. There has been noted an erosion 1½ in. deep in the old reinforced-concrete sheet-pile bulkheads, caused by the gravel thrown against it. This is sufficient to expose the steel reinforcing rods. It is evident, therefore, that any reinforced-concrete slabs exposed to the beach section would last but a few years. Where once a weak point in a bulkhead fails, letting the sea in, it is but a short time until the damage extends.

With a sea wall of gravity section there is no such danger. If the concrete be made of cement of the proper chemical composition, there is no danger of its chemical disintegration by sea water. Where concrete sea walls have apparently suffered from the action of the sea water between high and low tide, the damage has been due not to chemical disintegration of the concrete by the action of the salt water, but to the saturation of the concrete surface, with alternative freezing and thawing of the contained water, the resultant contraction and expansion of which mechanically destroys the face of the wall. Needless to say, this trouble will not be encountered in Southern California.

PROPOSED CONCRETE WALL

The proposed concrete wall at Venice embodies the best principles of sea-wall design. It has an elliptically curved face, which is the natural form of the wave, and is therefore best suited to changing the motion of the water from horizontal to vertical. At the bottom the curve is tangent to the slope of the beach. It therefore guides the wave from the beach to the wall and vice versa with the least possible disturbance.

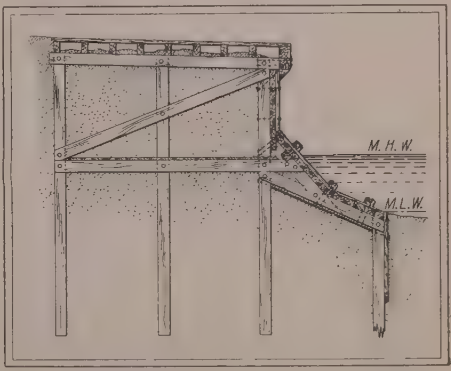
Above the curve the wall slopes slightly backward, but has a slight coping at the top, just sufficient to prevent the wave being thrown upon the promenade back of the wall. This coping is carefully designed to turn the wave so that it shall fall on the apron, rather than on the beach in front of the wall. Scour of the beach at the toe of the wall will therefore be eliminated. To prevent undermining of the wall by a lowering of the beach in any exceptional storm, the sheet piling necessary during construction will be cut off at the toe and left in place.

The mass of the concrete is so distributed as to place the greatest resistance where the waves will strike with the greatest violence. It also offers the maximum resistance to the sand pressure from the back. Under present conditions such a wall should cost about $50 per linear foot.

SUBSTITUTE ROCK WALL

As an alternative to the above concrete wall there is suggested a random rock sea wall as shown. The timber bulkhead and promenade shown in the same figure should also be constructed, the rails being left in place for the handling of material which may be necessary to bring the wall up to grade at points where a solid bottom is not at first found, or where some settlement may occur as the result of being particularly exposed to local scouring action.

This timber construction should last from twelve to fourteen years, at the end of which time or at any earlier period it can be replaced by a concrete pavement and a light parapet wall, the latter cast either directly on settled and compacted rock sea wall, or immediately behind the original timber sheet piling. In this way the neces-



TIMBER IS EFFECTIVE BUT LESS DURABLE

sary settlement and solidifying of the sea wall would be provided for and a considerable saving effected in first cost.

This wall has much to commend in its flexibility, low cost and ease of maintenance. By flexibility is meant the power to adjust itself to any local scour which may take place from time to time. In the case of any rigid construction, such as a concrete wall, unless a solid natural foundation is reached or an expensive pile foundation driven, an undermining of the wall might result in the failure and destruction of a considerable part of the wall, with resultant damage to property and heavy expense for reconstruction. With a wall of random rocks this could never occur, as scouring at the base of the wall would only make the rocks settle more firmly into place, offering additional protection to the bulkhead and walk in its rear. Repairs could be made easily and inexpensively by placing additional rock on the top of the wall from cars placed directly where needed on the track remaining in the promenade floor. The cost of such a wall should be about $40 per linear foot, including pile-supported walk.

TIMBER SEA WALL

Should even the rock wall be deemed too expensive a timber wall such as is shown in cross-section may be used. A wall similar to this has been recommended by the New Jersey Harbor Commission for the protection of the New Jersey beaches. It will be noted that it is really the adaptation to timber construction of the principles embodied in the design of the concrete sea wall recommended in an earlier paragraph. It has longitudinal waling places on the face which serve to break up the return wave and prevent scour at the toe. It has the advantage of resiliency of timber which concrete does not possess. Additional stability is obtained by the placing of the middle horizontal brace opposite the point of greatest wave shock. The platform on this brace gives to the wall the added weight of the superimposed sand. This timber wall should cost about $30 per linear foot. It should be noted that this includes a board walk 20 ft. wide. The life of this timber sea wall should be about 12 years.

CONCLUSIONS AND RECOMMENDATIONS

After a careful and thoughtful study of all phases of the problem of the protection of the water front at Venice, we make the following recommendations:

1. That a sea wall of one of the three above recommended types be immediately constructed along the line of the old concrete bulkhead. The most satisfactory type will be a concrete sea wall of gravity section. A cheaper but equally safe type is the random rock sea wall. The timber sea wall will give equal protection, excellent appearance and less cost. Its main disadvantage is the necessity of its later renewal.

2. That a permanent groin about 300 ft. long be immediately constructed at the southerly limit of the erosion in last winter's storms. This groin should be lengthened later.

3. That long, permanent groins be successively constructed from Playa del Rey northward, at intervals of about one-third of a mile.

4. That the conditions at Windward Avenue be improved as much as possible immediately. To accomplish this all unnecessary piling under the various structures should be removed. No renewals should be allowed except those of a permanent nature, driven in accordance with a complete plan to be designed for the entire pier and adjacent structures. The intake pipe should also be relocated, so as not to interfere with the littoral drift. After the substructure of the pier and adjacent buildings has been, in the regular course of maintenance and renewals, reconstructed on permanent lines as above indicated, the breakwater should be entirely removed.

Mammoth Screw Pumps of New Design Develop High Efficiencies for Low Lifts

Performance of New Units Installed at New Orleans Drainage Station Exceeds Expectations During Recent Tests—Power Consumption Decreased

ONE NEW PUMP DISCHARGING AGAINST PARTLY CLOSED CONTROL GATES

RELATIVELY high efficiencies, with particularly good discharges at low working heads, were shown in the recent tests of the new Wood screw pumps installed by the Sewerage and Water Board of New Orleans to increase the capacity of the drainage stations. The tests were made on Sept. 27 and Nov. 24, 1915, and demonstrated that the new form of pump, designed by A. B. Wood, engineer of the Board, and now patented by him, is superior to the older units. The noteworthy advantage of the new screw pump, which differs from the older screw pumps in having a 12-ft. screw placed at the top of the siphon instead of being submerged, is found in the relatively high discharge per horsepower at low working heads—a very essential requirement in times of flood. The following is taken from information furnished by George G. Earl, general superintendent for the Board, and from a report of test made for the Board by W. H. P. Creighton.

GENERAL DESCRIPTION OF PUMP

The pump tested is one of the eleven similar units installed or to be installed in the various drainage stations for pumping the storm drainage of the city of New Orleans. The pump proper, shown by Fig. 1 and the photographs, consists of a cylindrical casing, 12 ft. in diameter and 13 ft. 9 in. long with its axis horizontal, and containing the impeller, or moving blades, and the stationary or diffusion blades. The diffusion blades are mounted in a watertight cone-shaped housing, within which is located a self aligning main bearing and a marine type thrust bearing. The inner cone is 8 ft. in diameter at the larger section and is reached through an oval-shaped watertight manhole opening through the top of the pump. In this way, this inner cone or chamber is at all times accessible for inspection or adjustment of the bearings during the operation of the pump.

On the suction side the pump is connected to a cast-iron 45-deg. bend, through which the shaft, provided with the proper stuffing box, extends and beyond which the riveted steel casing increases in cross-sectional area to 15-ft. in diameter at the lower end. Between the stuffing box on the pump and the 600-hp. motor, there is another bearing and a flexible coupling. The discharge pipe is also of riveted sheet steel, bolted to the pump casing, and contains a 45-deg. bend and sections of uniformly increasing diameter up to 15-ft. at the lower end.

CORRECTIONS IN TESTING

As the tests could not be made under normal conditions of operation certain artificial conditions had to be created. The water on the suction side of the canal was allowed to accumulate by not pumping every day. To secure the necessary lift, the gates controlling the direction of discharge from the new discharge basin were almost entirely closed, so that in the basin an artificial discharge head of any desired height could be obtained by increasing or decreasing the opening of the gates, which are of the partially-balanced ships' rudder type, operated by hydraulic pistons.

Under these artificial conditions, when the water on the suction side was higher than on the discharge side, there was a slight leakage of water through all the gates and valves of the old station, found to be 1.83 cu. ft. per second. When condi-

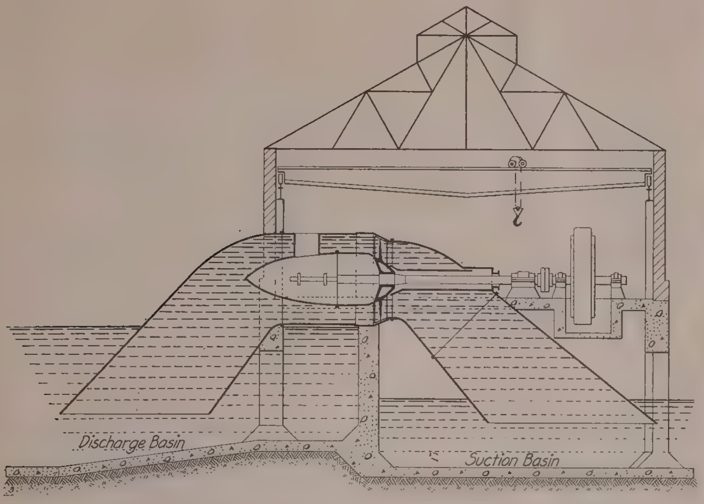
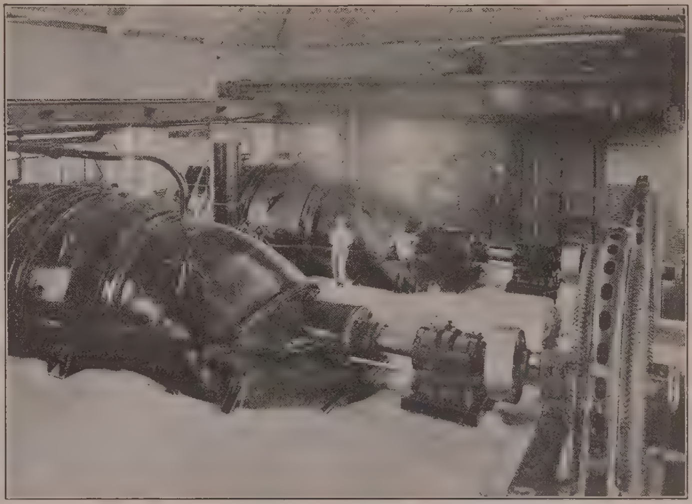


FIG. 1—DIAGRAMMATIC SECTION THROUGH NEW PUMP



INTERIOR VIEW OF PUMPING STATION WITH TWO NEW UNITS

tions are reversed, the amount of leakage becomes uncertain, but it could not be less, especially during the latter part of the test when the difference of head is greater and the water tends to press the gates from their seats.

A more important correction, which could be quite accurately measured, arose also from the artificial conditions necessary. The water was discharged into an empty canal 3 miles long. As the length of the water flow increased the head necessary to cause the flow at the pump end increased, which resulted not only in a constant increase in the area of the water cross-section at the measuring platform 600-ft. from the pumping station, but also in a reservoir of water of increasing volume, which had been discharged from the pump and did not pass the measuring station during the time the Pitot tube traverse of this cross-section was being made. This reservoir effect was considerable until the pump at the other end of the canal was started, and the water level of the canal assumed a nearly constant slope.

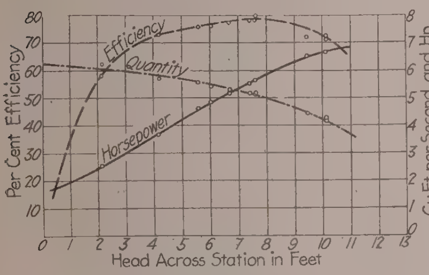


FIG. 2—TESTS OF 12-FT. SCREW PUMP

RESULTS OF TESTS

The result of one test shows that the pump raised 559 cu. ft. of water per second through a height of 5.572 ft., and 519.8 cu. ft. of water per second through a height of 7.6 ft., the pump making between 75 and 76 r.p.m. as driven by the 600-hp. synchronous motor, and the efficiency varying between 76 per cent and 80 per cent. The specifications required a maximum delivery of 550 cu. ft. of water per second, through a lift varying from 5 to 9 ft. when the motor was making 75 r.p.m. The efficiency expected was 70 per cent. The pump not only shows a remarkably high efficiency at the higher lifts, but uniformly high efficiency at varying lifts.

The curves in Fig. 2 show the characteristics of the new pump as shown by the tests, when working at the constant speed of 75 r.p.m. Figs. 2, 3 and 4 are plotted with lifts instead of quantity as abscissas, because for low lift pumps this brings out the essential characteristics more clearly. The efficiency curve of the new 12-ft. screw pump is practically the same as the calculated curve. It is also substantially the same curve as was demonstrated in the 30-in. pump of the same type, which was originally built and very thoroughly tested before the 12-ft. pumps were contracted for.

Fig. 3 shows the comparative efficiency curves, and the relation between the old and the new pumps. The new screw pump, which gives its best efficiency at 7 to 8-ft. lift, shows a higher efficiency than the best of the old pumps at its best point, an 11-ft. lift. Fig. 4 shows the discharge in cubic feet per second per applied brake horsepower for the 75 r.p.m. wood screw pumps, and for the groups of pumps considered in Fig 3. The best one of these old pumps, measured in this way, adds only 50 per cent to its capacity per applied horsepower as its lift drops from its point of maximum efficiency down to zero, while the new screw pump increases its capacity per applied brake horsepower 300 per cent from its lift for maximum efficiency down to zero.

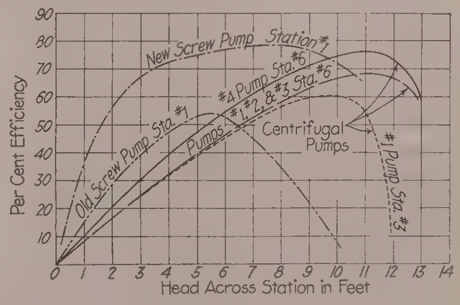


FIG. 3—COMPARATIVE EFFICIENCY CURVES

COMPARISON WITH CENTRIFUGAL PUMPS

The tendency to increase the quantity of water discharged at constant speed of operation as the lift decreases from the point of best efficiency exists in both types, and is slightly greater in the centrifugal pump; to do this, however, the centrifugal pump frequently requires a constantly increasing applied horsepower, with the result that its power requirements must be applied with an especial view of meeting the overload which its lack of efficiency at its lowest lift produces. The new screw pump, on the other hand, when operating at a constant speed, shows a rapidly decreasing power demand as its lift decreases, and while it still maintains an increasing discharge it only uses its maximum power at its maximum lift.

In a system operated electrically from a power station at constant speed, as exists in New Orleans, with power and pump capacity designed to give the required output under those low lift conditions which require the greatest quantity of discharge, the power required to operate all units will be much less with screw than with centrifugal pumps; and since, as the lift increases the available flow approaching the station decreases and less pumping units have to be operated, the power required to operate the pumps at a low lift will still suffice to operate enough units as the lift increases to take care of the decreasing flow. With pumps driven by power units capable of some speed variations, the characteristic of the screw pump is such that available power can be utilized at an increased speed at lifts far below the rated lift without the serious sacrifice of efficiency which an increase of speed entails with centrifugal pumps.

ADVANTAGES IN FLOOD TIMES

The function of a drainage pumping station is to maintain the water level on its suction side lower than the water on its discharge side. When it has just ceased to do this it really becomes an obstruction instead of an asset, and its crucial test is its capacity to discharge more and more water with less and less power per unit as the lift per unit discharged de-

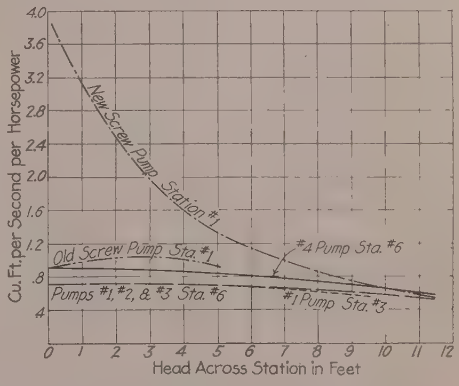


FIG. 4—COMPARATIVE CAPACITY CURVES

creases and the necessity to pump, therefore, is most urgent. Just at the most crucial point when many pumping stations begin to act as an obstruction, because of the water being at the same level on both sides, from three to five times as much water per applied brake horsepower can be disposed of with pumps having the characteristics of these new pumps as with pumps having those indicated in the diagram for the earlier pump installations in New Orleans, or with the best design of centrifugal units.

The experience heretofore at New Orleans has been that during great storms, when lifts were much below the rated lift, the older forms of pumps overloaded their motors and also overloaded the power stations, so that all pumping station units could not be maintained in service. With the eleven additional screw pumps and less than enough additional power to operate them at their rated lift, because the flow at rated lift can never supply all pumps, this condition will be reversed, and the decreasing amount of power required to operate the new pumps, as their lift decreases, will more than compensate for the excess amount required by the old ones when their lift decreases and the necessity to pump is greatest.

In connection with the tests of the new screw pumps, and in comparing their efficiency with the efficiencies frequently quoted, especially on centrifugal pumps, it should be remembered that the lift in this case is measured from still water in the suction canal to still water in the discharge basin. Thus no credit is given to the pump for the friction in the suction and discharge pipes and the lost head both at the entrance of the suction pipe and at the exit from the discharge pipe, all of which losses are eliminated in tests which credit the pump with the efficiency indicated by piezometer heads taken on each side of the pump itself.

ADVANTAGES IN OPERATION

In order to start the submerged pumps of the older installation with synchronous motors, it was necessary to have telephone communication with the power station and to slow down an engine and bring the pumps up to speed gradually, and when in synchronism to throw them over to the operating bus. This was a tedious and delicate operation not always successfully accomplished on the first trial, and much time was lost in its accomplishment just when this time was of the utmost importance.

In designing the new extensions it was recognized that the new pumping units must be as large as possible and their method of starting more simple and certain than that above described if they were to be of the greatest possible use. By adopting screw pumps there was precedent for much larger units than have ever been built in centrifugal pumps, and by setting these screw pumps in the summit of the siphon they can be started in an empty case by the mere throwing in of a switch, after which the air is exhausted from the pump case, and the pump takes its load gradually without any telephoning to the power station or any chance of being put out of step.

The new pumps were designed for the Sewerage and Water Board of the city of New Orleans, of which George G. Earl is general superintendent and Alfred Raymond, general manager of drainage, by A. B. Wood, mechanical engineer, who holds patents covering this type of pump. The manufacturer was supplied with all shop and detailed drawings. The pump castings and parts were manufactured and erected by the Nordberg Manufacturing Company, of Milwaukee, Wis. The motors were manufactured and installed by the Allis-Chalmers Manufacturing Company, of the same city. The tests were made under the supervision of W. H. P. Creighton, dean of the department of technology, Tulane University. S. G. F. Haas had charge of all preliminary tests and worked out the results of the tests, and assistant engineer Louis C. Frantz had charge of the electrical calculations and observations.

Literature

For the Civil Engineer and Contractor

New Publications

METHODS FOR THE EXAMINATION OF BITUMINOUS ROAD MATERIALS.—By Prevost Hubbard, chemical engineer, and Charles S. Reeve, chemist. Bulletin 314, U. S. Department of Agriculture, Office of Public Roads. Paper; 6 x 9 in.; 48 pages; illustrated. Washington, Government Printing Office.

EXPERIMENTS ON THE DISTRIBUTION OF VERTICAL PRESSURE IN EARTH. By R. B. Fehr and C. R. Thomas. Bulletin 8, Engineering Series, Pennsylvania State College. Paper, 6 x 9 in.; 75 pages; illustrated. State College, Pa., Pennsylvania State College Engineering Experiment Station.

THE ARCHITECTS' AND BUILDERS' POCKET-BOOK. A Handbook for Architects, Structural Engineers, Builders and Draftsmen. By the late Frank E. Kidder. Compiled by a staff of specialists; Thomas Nolan, professor of architectural construction, University of Pennsylvania, editor-in-chief. Sixteenth edition, rewritten. Flexible leather, 4½ x 7 in.; 1816 pages; illustrated. New York, John Wiley & Sons, Inc., $5 net.

PROPOSED STANDARD SCHEDULE FOR GRADING CITIES AND TOWNS of the United States with reference to Their Fire Defenses and Physical Conditions. Prepared by the National Board of Fire Underwriters. Flexible leather, 5½ x 9 in.; 61 pages. New York, National Board of Fire Underwriters.

Books Reviewed

Railway Maintenance Engineering

Author, William H. Sellew, non-resident lecturer on railway engineering, University of Michigan. Cloth, 5 x 7½ in.; 360 pages; 194 illustrations; 6 folding plates. New York, D. Van Nostrand Company. $2.50 net.

REVIEWED BY A. F. COMSTOCK

Associate in Railway Engineering, University of Illinois.

The unabridged title of this book is "Railway Maintenance Engineering with Notes on Construction." The reader, after viewing this heading and reading the preface, naturally expects to find the subject of maintenance-of-way adequately covered. In this expectation he is likely to be disappointed. Maintenance organization, which is certainly one of the vital problems of the maintenance engineer, has not been touched upon. The important subjects of track inspection, and of reports, records and accounts are also among those missing. Besides these errors of omission, there are two other prominent defects; one is the sketchy and apparently hurried treatment which characterizes the fifteen chapters; the other is the small and inappropriate size of book. The latter stricture has given the book a general appearance of mediocrity; and small, indistinct half-tones have robbed the illustrations of much of their potential value.

The usual claim that the book is suited to the needs of both students and practical engineers, is made in this case; but the reviewer feels that neither viewpoint has been well preserved. Thoroughness and breadth have been sacrificed to variety and haste. For instance, in referring on page 219 to "Section Work," this typical sentence occurs, constituting, by the way, almost the sole reference to section organization: "The length of a section, or the track under each foreman, is in the neighborhood of 3 or 4 miles of line, but may be considerably larger on lines where the traffic is light." Such radical condensation is especially unwarranted in view of the relatively large space given to the last two chapters on the minor subjects of "Icing Stations" and "Signals and Interlockers." Substantially one-fifth of the entire 350 pages of text is devoted to these two topics. The chapter on "Signals and Interlockers," incidentally, is the longest in the book.

Following are the fifteen chapter headings: "Engineering," "Land," "Grading," "Bridges, Trestles and Culverts," "Ties," "Other Track Material," "Ballast," "Maintaining Track and Right-of-Way," "Station and Roadway Buildings," "Water Stations," "Fuel Stations," "Shops and Engine Houses," "Icing Stations" and "Signals and Interlockers."

Water Power Engineering

Author, Daniel W. Mead, professor of hydraulic and sanitary engineering. University of Wisconsin. Cloth, 6 x 9 in.; 843 pages; 437 illustrations. New York, McGraw-Hill Book Company, Inc. $5 net.

REVIEWED BY D. R. COOPER

Consulting Hydraulic Engineer, New York City

This book is so important in its field that it seems proper to review it somewhat more fully than is customary with new editions of standard works. As to its scope, the book may be said to be the most satisfactory work published on this important branch of engineering. It comprises a substantially complete outline and discussion of the principles and processes involved in water-power engineering. The treatment of the subject and its various phases is generally comprehensive and is descriptive of practice rather than an exposition of set theories. The volume will probably prove more useful to the student than to the designing engineer, but considerable portions may be read with interest and profit by most practising engineers.

Chapter 1 is largely historical. Chapter 2 contains a good elementary discussion of power and energy. Chapter 3 is an excellent discussion of power-plant load characteristics and their influence on plant design and equipment.

Chapters 4 and 5 treat of the factors affecting the flow of water in open channels and the various methods used in the determination of the velocity of flow. Chapter 6 analyzes the effect of variable flow on available power, while the next two chapters deal with the influence of pondage, storage and variable head. The use of duration curves to supplement the hydrographic diagrams is an improvement conducive to accuracy and clearness in the determination of these influences.

The next five chapters relate to waterwheels, the hydraulics of the turbine, turbine details and appurtenances, and the selection, arrangement and testing of turbines. The chapter on turbine analysis and selection is very good and properly omits any extended consideration of the subject of detail design of runners as being of interest to turbine designers rather than to the average hydraulic engineer.

An excellent explanation of specific speed is given, and its significance and use in turbine comparisons is thoroughly explained. A description of various diagrams for comparing turbine characteristics is presented in such manner as to direct the intelligent selection of turbine equipment. The author continues to use the unfortunate term "characteristic curve" to describe the somewhat complicated diagrams showing the interrelationship of factors affecting turbine performances. The use of the factor "specific power" is an innovation in the literature of hydraulic turbines. The section on turbine testing relates more to the history of testing and to details of Holyoke tests than to modern field tests of units in place.

Chapter 14 deals with speed regulation in a generally satisfactory manner, but gives rather scant consideration to the subject of surge-tank design except as affecting speed regulation. The discussion of surge tanks is practically confined to simple standpipes.

In referring to the differential regulator the misleading statement is made that the relatively rapid drop in effective head is opposed to good speed regulation, giving the impression that the device as a whole is unsatisfactory, which is contrary to experience with these regulators.

The design of surge tanks calls for very thorough engineering and seriously affects water economy and the cost of feeder pipes, penstocks, penstock valves and waterwheels, all of which are therefore important considerations in surge-tank design, although they do not receive much if any attention as such in this treatise.

The next three chapters relate to governors, arrangement of reaction wheels and the selection of machinery and the general design of water-power plants. The sections on economic friction losses and the determination of economic diameters of feeder pipes and conduits contain some confusing statements. In justice to the author it may be stated that his treatment of these topics follows the stereotyped processes used by many engineers in the solution of these problems. Nevertheless it seems to the reviewer that the time is ripe for pointing out the inadequacy of the procedure outlined by Professor Mead.

Chapters 18 to 21 contain descriptions of various plants and general arrangements of dam, power house, etc., and a statement of the general principles involved in the design and construction of dams and appurtenant structures. The last three chapters relate to costs of plants and power, and include an admirable exposition of the hazards of water-power enterprises. The financial and commercial considerations involved in the engineering examination of a water-power project are clearly set forth. These chapters are calculated to effect the disillusionment of many readers as to water-power values, and are commended to all who would gain a clear conception of the economics of water-power development.

Such details of design and construction as the author seriously essays to cover are treated thoroughly, and include the features that usually receive the most consideration at the hands of the majority of hydraulic engineers. Some of these have been rather exhaustively treated at the expense of certain others that many engineers would consider equally important. For example, the design of large conduits, large curved draft tubes, low-head concrete scroll cases, large head gates, trash racks and trash-disposal apparatus, and the testing of turbines in place, are subjects which many readers will wish might have been treated more fully.

There are some noteworthy differences between this and the first edition. The treatise has been materially improved in the parts that have been retained and expanded. The chapter on hydraulics has been omitted as being not simple enough for the beginner and not complete enough for the hydraulic engineer, although some of the same matter has been included in other chapters. The chapters on rainfall, meteorology and related topics have been omitted, but the preface contains an announcement of the author's intention to cover these subjects in a separate volume on hydrology.

This volume is printed on thinner paper and the book is somewhat thinner than the first edition although it contains some sixty pages more. The lists of references to other literature have been extended and made more useful by adding references to recent literature and eliminating references to foreign works not generally accessible.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Roots Crack Cistern

SIR: I have before me a problem which I suppose has been solved many times before, but as there seems to be little literature dealing with the subject, I should appreciate any help your readers may be able to give me. A cistern has been dug in a clay soil and made sufficiently watertight by a coat of cement about 1½ in. thick plastered directly upon the earth. The cistern has given good service for five years. Recently it was discovered that one side of the cistern has become cracked open by the roots of a Carolina poplar tree which stands near by. How may I make repairs and not injure the tree?

STEWART T. SMITH.

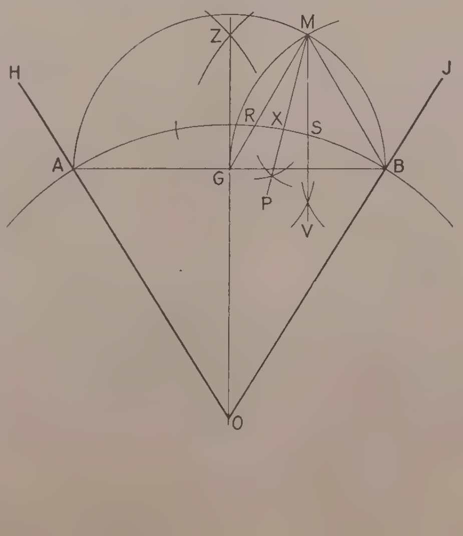
Bridgeport, Conn.

To Trisect an Angle

SIR: In the Engineering Record of July 31, 1915, I saw a very interesting solution to the question "how to divide an angle into three equal parts," signed by B. K. Coghlan.

Another solution of the problem, requiring only a rule and a pair of dividers is the following:

From the point O as center, draw an arbitrary arc and chord AB; bisect AB by OZ and from G as a center draw the semicircle AMB with a radius GB. Then swing the arc GM with B as a center to locate M; bisect GB by MV and from R and S as centers with a radius RS draw two arcs and join their intersection P with the point M, locating X. The portion XB of the arc is equal to one-third of the total arc AB.



NATAL ARNAUD,
Lieutenant, Brazilian Navy.
Rio de Janiero.

Why Is Registration in Civil Engineering Decreasing?

SIR: I am much interested in your editorial and the statistics on the registration in civil engineering and in engineering in American universities and technical schools, in your issue of Dec. 18, 1915. As you doubtless recognize, the curves would have a greater value if they included a larger proportion of the schools. For instance, the Worcester Polytechnic Institute has shown great vitality in civil engineering and there has been a steady gain for the past ten years. The numbers have grown from 48 to 81 between 1905 and 1910, and from 81 to 112 between 1910 and 1915. I cannot state what the exact registration for 1916 will be, because there are always additional students in the second term. These numbers include only three classes, as the freshmen do not designate their choice of department until they have been promoted to the sophomore class.

Your analysis of the reason for the decrease in civil engineering registration seems to me sound, but there are other considerations besides the readjustments due to changes in the profession and salaries and in the opening up of new fields for applied science. The graduate school idea must affect the apparent registration in universities. At Harvard the establishment of a graduate department threw all undergraduate students in engineering into the college where their names disappeared from registration as engineering students.

The consequence was that the total registration was confined to those in the last years of professional study. I think the same thing would be true in a large number of universities where the preliminary training is in the academic departments.

The graduate school must also affect the total number of men who enter the profession of civil engineering, as well as those who go into other branches. In the first place, it is likely to scare off young men who are not fitted for engineering at all; and, in the second place, it raises the standard to the apprenticeship or novitiate in the profession. I am inclined to think that putting engineering on a graduate basis may tend to make broader citizens of our engineers, but whether it will make better engineers or not remains to be determined by many years of experience. Some of our greatest engineers have had little or no schooling. Another side of this is that the large corporations have had a decided effect upon the distribution of men in the different branches of engineering and, by reflex action, upon the student registration. The profession has become standardized more or less and there is a tendency to make all engineers salaried men. Doubtless there are as many independent engineers who are doing consulting work as there ever were, but the percentage of those who by their own initiative have become successful engineers seems to me decidedly smaller.

The statistics and diagrams of college registration are not altogether satisfying, as many young men transfer from one branch of the profession to another during the school period or afterward. This is particularly true as between electrical and mechanical engineering, and to some extent for civil engineers, especially when sanitary engineering is taken as a separate profession.

This whole subject is an interesting one and it is gratifying to have a periodical of your standing take the matter up. We need the advice and help of outside men in the colleges and technical schools.

Ira N. Hollis,
President, Worcester Polytechnic Institute.
Worcester, Mass.

Sir: I have read your article entitled "Registration in Civil Engineering Is Decreasing," and your editorial comments on it. Our own experience in the University of Iowa, as you will note from your diagrams, has not been such as to give us any anxiety or to disturb our operating conditions, except to require a couple of years ago a slight increase in our instructional staff. And, so far as the enrollment of all engineering students is concerned, I am not sure that there is anything to be alarmed about anywhere, unless in the case of some particular institution that is suffering for local causes.

If you will go back further than 1910-11 and plot the engineering attendance for the past 30 or 40 years I think you will find, as I believe it was at one time shown by President Ricketts, that engineering attendance curves follow pretty well the financial prosperity curves, the low points of the attendance curves generally lagging a little behind the low points of the prosperity curves. I have been accustomed as a result of a study of these curves to say that I expect a maximum attendance in the year of the beginning of a financial depression and a minimum attendance some five years thereafter. I am rather inclined to think that this will, at least in part, explain anything that may seem for the moment peculiar about total enrollment.

As to the decline in civil engineering enrollment, I am disposed to attribute this more to the interest in electrical engineering aroused in the high school boy when he studies physics, together with the great amount of publicity that is given the more spectacular electrical phenomena; and all this in spite of the fact that, so far as our experience goes in recent years, electrical engineering graduates are slower to secure positions than either mechanical or civil engineering graduates.

I agree with you that scientific agriculture is probably responsible for some falling off in engineering attendance, but I am inclined to believe that this is a good tendency. And it is possible that the better understanding of engineering compensation is responsible somewhat for the falling off in total attendance. I have tried to be perfectly fair with the young men in the state in this matter, as a bulletin sent some time ago to high school seniors will indicate, and either in spite of or because of this frank statement our attendance has gradually increased. However, there is evidence of a halt just now, which perhaps, because of the apparent approach of more prosperous conditions, may be only temporary.

I am rather inclined to think that in the electrical field the supply has perhaps fully reached the demand and possibly is in excess. We know that there are in certain parts of the country many idle civil engineers, in spite of which I have had more calls several times over for young civil engineers to fill subordinate positions this fall than I could supply.

Decline in Interest in Railroad Civil Engineering

There is perhaps one reason for falling off of civil engineering students that has not been mentioned. I refer to the decline of interest in railroad civil engineering. I believe it is a fact that the standard of engineering labor on railroads as a rule throughout the country is rather low. The young man who can learn to read the rod and do a few sums in arithmetic and is willing to work for a low wage is doing the work that some college people think should be done by their graduates. If the young man who can read the rod and do the sums in arithmetic has intelligence and energy he is undoubtedly a better assistant than the college graduate who has not these characteristics, and unfortunately there are such. But from my observation I am inclined to think that railroad engineering work would be better done if salaries were so improved as to make it possible to employ more thoroughly-trained men for subordinate positions. Although my own specialty is railroad engineering, I have been unable to interest many of my graduates in that branch of work. With few exceptions those whom I have interested have not cared to remain in it. Of course, as an offset for this, there has been some growth in municipal and sanitary work, and I presume that it is but a minor influence.

On the whole, I fancy we are merely at or approaching a low point in an irregular curve that has a general, though slow, upward tendency; and, except for the possible temporary embarrassment of those institutions that have prepared for larger bodies of students than they are now receiving, I think there is not very much to be concerned about. Although we are not one of the larger schools, we were ourselves embarrassed in this way some three or four years ago, at which time we slightly reduced our faculty.

William G. Raymond,
Dean, College of Applied Science, State University of Iowa.
Iowa City, Iowa.

Sir: Attention has been directed to the gradual decline in attendance at engineering schools. Some of the causes for this have probably been given. There may be other causes which are more fundamental, although possibly not so evident. American engineers are inclined to be individualists of an extreme type. The few who reach the heights seldom stretch forth their hands to aid the many who struggle against almost overwhelming difficulties below them. During the early history of the profession surveying furnished the most attractive field to the engineer. Considering the large number of men engaged in this kind of work, the literature of the past fifty years is very limited and unsatisfactory. Surveying furnishes an example which serves to illustrate the characteristic of the engineer which I propose to discuss.

The work of the General Land Office began at a time when qualified surveyors were almost unknown. Land surveying improved but slowly, if at all, even after engineering schools furnished men adequately trained for the work. While surveying, properly performed, is purely scientific in character, yet it is on a scientific basis only here and there throughout the country. All civil engineers are interested in surveying in a general way, because much of their work begins with measurements on the ground. As a separate branch in which they might specialize they have come to regard it as something elementary and something that may be performed by any man who chooses to call himself a surveyor.

Surveying Is Poorly Taught in the Engineering Schools

Even engineering schools have been tainted with this kind of false sentiment. Generally speaking, there is no subject so poorly taught in our engineering schools as is surveying. It is generally a minor subdivision of the civil engineering department. It is frequently taught to freshmen and commonly to sophomores. Many of the heads of departments have long since lost interest in surveying as a specialty. The financial reward for surveying work today offers them no inducement. They probably had some sad experience, during their earlier years, when thrown into competition with incompetent and irresponsible surveyors. Because employers could not judge the relative quality of work performed by competent and incompetent men, those who were willing to accept employment at starvation wages and furnish results that "seemed" to be precise, were given all the advantage. Only the capable man realized the situation. The engineer who has become familiar with the public land surveys appreciates how detrimental this example has been to his profession. The early engineer began to lay a foundation for his professional edifice at a time when the General Land Office was openly breaking down his every effort to place surveying on a scientific basis.

As a result, many of our schools, which should be teaching young men how to recover ground already lost, almost forget that surveying has any relation to science, and lay all stress on branches that seem more promising at the time. The young instructor, who has not won his spurs in the fields which interest the heads of departments, is intrusted with the courses in surveying. He is being "tried out." His limited experience does not enable him to arouse much enthusiasm among his students. He does not know, probably, why it is that those higher up in his department look upon the subject assigned him with some contempt. He does not know that, where surveying is protected by specifications which demand results of high quality, engineers have opportunities that are inviting to the best of engineering talent. He has not become familiar with those branches of government service which have always performed surveying work in a highly creditable manner. He does not know what the states have done to place surveying and other branches of engineering on a better basis. Students leaving schools where such instruction prevails are not inclined to be helpful in any movement which tends to improve the practice of surveying or to uphold professional standards generally.

SLIDING SCALE OF ACCURACY IN SURVEYING

The surveyor has acquiesced in a system which prescribes a sliding scale of accuracy depending upon the value of the lands surveyed. Unfortunately, some texts on surveying advocate such a practice. The measurement of distance involves scientific considerations. The value of lands involves financial considerations. The two are not connected in any way. A line measured to-day over lands having a value of $1 per acre has the same length as when measured fifty years hence, when the lands have a value of $1,000 per acre. Where an engineer fails to do his best work because of land values he establishes a reputation which retrogrades as the value of the land increases. We would not support a surgeon who performs operations in a more or less scientific way depending upon the financial ability of the patient. There may be professions which thrive on theories which permit practitioners to regulate their usefulness to employers and to the public in accordance with monetary standards alone. These professions are not supported on a scientfic foundation. No scientific profession can live and continue to enjoy the esteem and respect of the people it is presumed to serve unless it adheres to the letter and spirit of the natural laws which should support it.

Surveying furnishes one, but not the single, "horrible example" for engineers to study. When we review its history, we must admit that the engineer has never exerted an influence there which has brought about any general improvement. The object lesson it furnishes should be plain to all. The engineer is satisfied, for the time being, to remain in a narrow channel and to retreat from one field to another as the greedy, the incompetent and the irresponsible order him to move on. He labors to-day between elements that are fully organized. Even his bretheren in architecture have a definite life work that is their own. With every other profession organized for its own protection, with labor united in its strife against centralized capital, the engineer occupies a field which is one month a vacuum and the next an area of extreme pressure. Between the upper and lower mill stones he is ground to fit whatever holes there may be for him in the social fabric.

Engineers have organizations. These are for the purpose of providing an opportunity for discussions of matters of "shop." Engineers might learn something to their advantage by attending meetings of some good labor union. An engineer would probably anticipate, should he be invited to attend a session of a plumber's union, that the members thereof would discuss the methods used in threading pipe and wiping lead joints. He would be greatly surprised to find these men interested in matters of government; to find that they are far in advance of him in the study of economics; that they know what plumbers are doing in foreign countries and what they are accomplishing here under an organization that is personal, sympathetic and effective.

There may be something in this brief review which will disclose at least one reason for the decrease in attendance at engineering schools. Parents, and young men who are considering a life occupation, probably know that engineers are good servants, but that they rarely become masters, in the broad sense of the term. Young men who spend from four to six years in preparation at our universities prefer to select a field, in the beginning, which has some well-defined limits and in which only qualified men may practice. While many parents and prospective students may not be able to analyze the objectionable features of the field of the engineer, yet these are plain, superficially, to all who observe.

CLARENCE T. JOHNSTON,
Professor of Surveying, University of Michigan.
Ann Arbor, Mich.

Decimals of the Degree and of the Full Circle

SIR: Relative to F. H. Frankland's letter in your issue of Nov. 27, page 671, I should like to make a few remarks and additions. Contrary to Mr. Frankland's assumption, I was not under the impression that the centesimal division of the degree is something new. In addition to the tables of Briggs, Roe and Oughtred, in which the decimal or centesimal division of the degree was used instead of the sexagesimal, French mathematicians of the latter part of the eighteenth century, among them being Prony and Legendre, used the centesimal division of the quadrant. As I mentioned in my previous letter, some French and Spanish instruments are still made for the use of this system.

The tables devised by C. Bremiker, mentioned by Mr. Frankland, were published in 1872. A tenth edition of these tables, revised by A. Kallius, was published in 1906. This edition contains 158 pages and gives five-place figures for each hundredth of a degree (centesimal), besides logarithms, and addition and subtraction logarithms ("Logarithmisch-Trigonometrische Tafeln-mit fünf Decimal-Stellen").

Tables giving functions of the centesimally divided quadrant were published in Berlin in 1799 by J. P. Hobert and L. Ideler under the title of "Nouvelles Tables Trigonométriques," and in 1801 C. Borda and J. B. J. Delambre published in Paris the "Tables Trigonométriques Décimales." In 1891 the French Government published an eight-figure table containing log sines and tangents for every ten seconds (centesimal) of the quadrant. This work is the "Service Géographique de l'Armée: Tables des Logarithmes à Huit Décimales . . . Publiées par Ordre du Ministre de la Guerre" (Paris, Imprimerie Nationale, 1891). The log sines and tangents in these tables were taken from the manuscript of the "Tables du Cadastre" of Prony, who in 1784 was commissioned by the French Government to undertake the work. The tables calculated by Prony and his associates have never been published in their entirety. They were calculated to fourteen places and occupied the time of about 100 men for two years.

While the subject of the centesimal division of the degree and quadrant is not a new one, it is practically new in this country. The non-use of the centesimal division is attributed in great measure to Vlacq's "Trigonometria Artificialis" using the nonagesimal division, which appeared the same year (1633) as Briggs' "Trigonometria Brittannica."

In any event, new or old, it is sincerely to be hoped that success will attend the venture of introducing the centesimal system.

R. C. HARDMAN.
Colorado Springs, Col.

SIR: Noting the discussion of the above subject in your columns in several recent numbers, I am prompted to say that in the early seventies of last century I had the vernier of a transit graduated in decimals of a degree instead of the usual sixtieths, to facilitate laying out railroad curves on location.

I found it vastly more convenient in the calculations and chord deflections to use decimals of a degree instead of minutes.

T. G. DABNEY.
Clarksdale, Miss.

SIR: The communications of R. C. Harding and F. H. Frankland concerning the decimal division of the degree in place of the sexagesimal calls to mind a unite of angle which was introduced by French mathematicians at the time of the French Revolution. This unit, called the grade, was defined as being one-hundredth of a right angle. A grade was divided into one hundred equal parts called minutes, and each minute was divided into one hundred equal parts called seconds. The symbols representing the grade, the minute and the second were ^{g}, $^{\backprime}$ and $^{\backprime\backprime}$ respectively. The great advantage of this centesimal system, as it is called, is that any angle, say 49 grades, 16 minutes, 77 seconds may be written in any one of the three ways: 49^{g}, 16$^{\backprime}$, 77$^{\backprime\backprime}$, 49^{g}, 16.77$^{\backprime}$, or 49.1677^{g}. This system, it should be observed, was never completely accepted by mathematicians, and its use has now been completely abandoned. It is, however, of some historical interest.

ALBERT LOUIS WECHSLER,
Columbia University.
New York City.

BEQUESTS received by the Massachusetts Institute of Technology during 1914 totaled $750,000. This sum is exclusive of a number of items in which the institute is the residual legatee or one of a group of institutions to be benefited in the future.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Progressive Illumination Makes Good Tunnel Pictures Possible

CONTRACTORS who have to take progress pictures of tunnels often find it difficult to get good results. Flashlights of the ordinary type illuminate only a comparatively short stretch of the bore and the resulting negatives lack perspective. To overcome this trouble, S. P. Brown, chief engineer of the Mount Royal Tunnel & Terminal Company, of Montreal, adopted a different scheme in making the photograph shown herewith. After the camera had been set up and the lens opened, a man with a magnesium blow torch mounted in front of a large screen was ordered to walk through the tunnel away from the camera. Thus the perimeter of the bore was illuminated for a long distance without having the direct rays of the light reach the camera and fog the plate. The result was a picture of unusually great perspective.

MOVING LIGHT USED TO GIVE THIS TUNNEL PICTURE UNUSUALLY GOOD PERSPECTIVE

Filling Scows to Dump Them

A GOOD method of removing a load of rock from a wooden deck scow, not generally known to river contractors in many parts of this country, was originated some time ago by one of the Porter Brothers, associated with Foley Bros., Welch, Stewart & Farquier in the construction of the Halifax ocean terminals. The method, now being used on that contract, consists of loading the scow with a list, towing it to the dumping place, opening a valve and filling the hull partly full of water. As the hull fills, the water runs to the low side and increases the list until the load begins to slide. The scow then shakes itself free of its burden and rights up. It can be siphoned out by the tug on the return trip. There is no chance of sinking the scow unless the load is confined so that it is unable to slide. In a long experience with this method, the Porter Brothers have never lost a boat.

Combined Electric and Time Fuses Give Best Blasting Results

By S. P. BROWN

Chief Engineer, Mount Royal Tunnel & Terminal Company, Montreal

OF the various methods of blasting which have been tried in tunnel heading work, electric fuses are commonly used in eastern America, while time fuses are more popular in the West. While the character of the ground and the local conditions must govern the choice of system to a very large degree, the writer has found that a judicious combination of both methods may usually be used to a very good advantage.

It is possible to get, at least through the Canadian Explosives, Ltd., or the Nobel's of Glasgow, Scotland, an electric igniter to fire time fuses in circuit with electric detonators of the match-head type. Thus the cut may be loaded with electric detonators and the side rounds, breakdown holes and line holes may be loaded with electrically ignited time fuses. By using the electric igniters the time fuses may be cut very short, from 2 in. long up, thus practically eliminating the danger of cut off holes and very much expediting the time required for blasting. Where the rock is very hard and tough, so that the cut holes do not always break to the bottom, it is usually wise to fire the cut first independently. Then if a second charge is necessary it may be connected up with the time fuses and the remainder of the heading holes ignited when the second cut shot is fired.

By using the time fuses around the cut the inside holes may be fired first in proper rotation for the most economical use of powder. By placing the longest fuses in the two bottom corner holes these will explode last, throwing the muck back from the face. This very much expedites setting up the drills after the blasting.

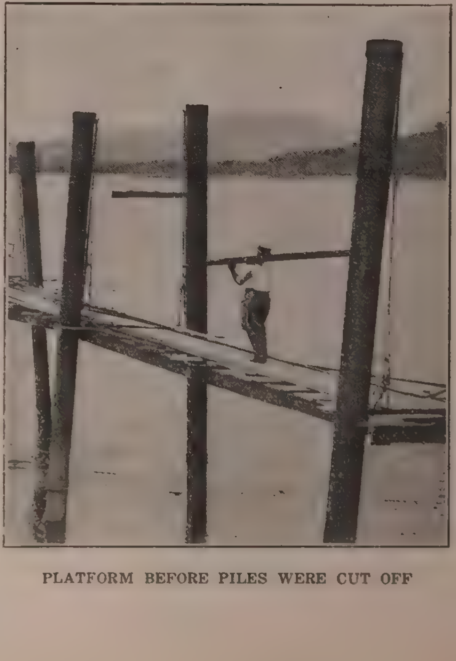
The electrically ignited time fuses were also used in the break-ups from the bottom heading of the Mount Royal tunnel in Montreal with equal success. There a great many lightly charged holes had to be fired in definite and regular sequence. In none of this work has the writer had any serious accidents or delays from the use of this method of shooting.

Pipe Piles Cut Off While Platform is Hung from Them

By ALEX. P. CRARY

Ancon, Canal Zone

A WORKING PLATFORM hung with hooks from the tops of 14-in. pipe piles 21 ft. apart was supported while the piles were cut off and concreted by first burning a hole in each pipe at cut-off grade with an oxy-acetylene torch. Other hooks were then slipped into these holes and the load of the platform transferred to them, after which the top hooks were removed and the piles cut off at the proper elevation with the torch. The stringers of this platform, which may be seen in the accompanying photograph, were set as fast as the piles were driven. They were carried out along the platform and a rope and S-hook attached to each end. As soon as the advance bent was driven the outer end of each stringer, carrying a man, was raised to the top of the next pile, over which the hook was caught, and the stringer lowered till the line held it. The back ends of the stringers were, of course, handled from the platform. The writer was contractor for the job on which this was done, that of constructing a landing stage for the quarantine station at Balboa, Canal Zone. Other features of the work, of which Rear Admiral H. H. Rousseau, engineer of terminal construction, had general charge, were described in this section of the Engineering Record for Dec. 25, 1915, page 801, and Jan. 1, 1916, page 27.



PLATFORM BEFORE PILES WERE CUT OFF

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Ninety-Year-Old Dam Removed on Completion of New Structure

Old Landmark on the Hudson River at Troy Makes Way for New 22,000-Yd. Concrete Power and Navigation Dam

BLAST THAT CUT SECTION OF EARTH DIKE

The completion of the new government dam across the Hudson River at Troy, N. Y., built in connection with the new tidewater outlet of the Barge Canal, was marked by the cutting last week of the first section of the earth dike behind which half of the old dam was torn out and the blasting five days later, on Dec. 31, of a channel through the remaining section of the dike. The old state dam, a short distance below the new structure, has marked the head of tidewater on the Hudson River since 1825. Between it and the new dam, which raises the pool level 2 ft. above the crest of the old dam and provides deep water up to the eastern terminus of the State Barge Canal, remained a pool, the head of which on the old dam varied from about 2 to 15 feet, according to tide and floods. The cutting of the earth dike, built to protect the floating plant from a rush of water while the western half of the old structure was being removed, has now lowered the pool and will ultimately bring tidewater to the foot of the new dam.

(*Continued to page 64, first column*)

Flood Breaks Concrete Cofferdam at Rochester, New York

A flood on the Genesee River at Rochester, N. Y., overtopped at midnight, Jan. 2, the 6-ft. concrete cofferdam behind which the rock bed of the river was being deepened on one side, and carried out 150 ft. of the wall. The work of lowering the rock channel of the Genesee River 6 ft. for ½ mile above the upper falls in the heart of the city is being carried on under contract by the Shongo Construction Company. A concrete center wall was built in the river, 3 ft. 8 in. thick at the bottom, 1 ft. 6 in. at the top and 6 ft. high, surmounted by 12-in. flash boards. Behind this dam the east half of the river bed was pumped dry and the rock excavation attacked with drills, three steam shovels and four channelling machines. The channel left west of the dam was 100 ft. wide.

About 8000 sec. ft. was flowing when the center wall was overtopped, according to information received from John F. Skinner, principle assistant to the city engineer of Rochester. Approximately 150 ft. of the wall broke into several sections and slid forward without overturning. Besides the heavier plant, three motor-driven pumps and six drills were in the excavation at the time, but all the drills and two of the pumps were gotten out. The other pump and 1000 ft. of standard-gage track were lost, and one workman came near being carried over the falls, which are 98 ft. high. The heavier plant is still in sight in the water, which on Jan. 5 was receding.

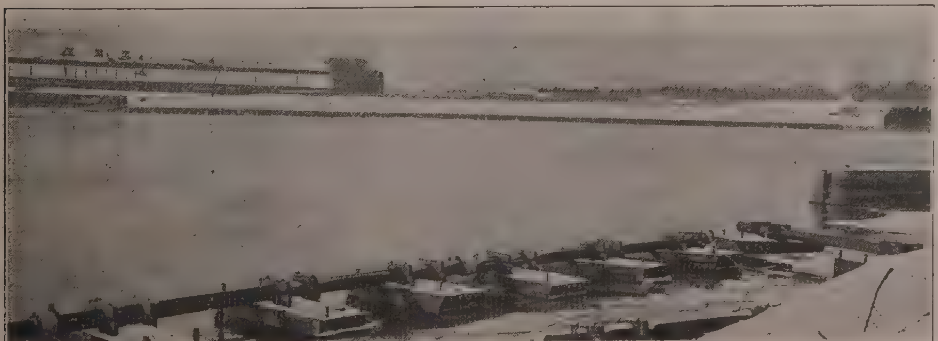
Worst Wind Storm in Twenty-six Years Visits San Francisco

On the night of Jan. 2 San Francisco was visited by the worst wind storm in twenty-six years. Although no extremely heavy loss centered at any one point, damage was general throughout the entire bay region. Of the 140,000 lines of the Pacific Telephone & Telegraph Company, 1500 were out of commission, it is reported.

Public buildings suffered an estimated damage of $15,000. Street railway service in outlying districts was stopped by landslides, inundations and drifting sand. The interurban schedules of the Southern Pacific were deranged by washouts and fallen trees.

One man was killed and others injured in San Francisco by falling signs. Other casualties were reported from suburban points due to drowning in the floods that followed the heavy rain. Watsonville reported a 3.5-in. rainfall and a fall of 4.6 in. was reported at Oroville.

The Spring Valley Water Company reports that the quantity of stored water is now 4,000,000,000 gallons greater than last year at this time.



HEADGATES, WEST SPILLING AND END OF LOWER GUIDE OF NEW DAM AT TROY

Engineer Is Appointed New York State Public Service Commissioner

Henry W. Hodge, Whose Firm Designed Singer Tower and Duluth & Superior Bridge, to Succeed Robert C. Wood

NEWLY APPOINTED PUBLIC SERVICE COMMISSIONER HENRY W. HODGE

Henry W. Hodge, consulting engineer, of New York City, has been appointed a member of the Public Service Commission of the First District, New York State, succeeding Robert C. Wood, resigned. Mr. Hodge has been engaged in engineering work for 34 years. The firm of Boller, Hodge & Baird, 149 Broadway, New York City, of which he has been senior member since 1912, designed many of the largest bridges and buildings in the country, among them being the Duluth & Superior Bridge, the cantilevers across the Monongahela and Ohio rivers at Pittsburgh and Steubenville, Ohio, and the Singer tower and Metropolitan tower in New York City. As a commissioner for the state of New York he passed upon the original design of the Blackwell's Island and Manhattan bridges in New York City. Later he was again appointed to pass upon the carrying capacity of the former structure. He also served the Canadian government as consulting engineer on the new design of the Quebec Bridge.

He was born in Washington, D. C., in 1865 and received his early education at Charles B. Young's private school in that city. He took up engineering work in 1881 as a member of the field force on surveys of various branch lines of the Chesapeake & Ohio Railroad in West Virginia under O. A. Veasey. In 1882 he entered the Rensselaer Polytechnic Institute, from which he was graduated as a civil engineer in 1885. He then became one of the assistant engineers of the Phoenix Bridge Company of Phoenixville, Pa., where he remained until 1891, when he became chief engineer of the Union Iron Works, New York City, engaged in steel building construction. In 1893 he resigned from that office to engage in private practice. He became assistant to Alfred P. Boller, in charge of bridge design and construction, in 1895, and a partner in the firm of Boller & Hodge in 1899. In 1912 the firm was enlarged by the admission of Howard C. Baird, and the name changed to Boller, Hodge & Baird. Mr. Boller died in the latter part of 1912, and Mr. Hodge became senior member.

Large Structures for Which Mr. Hodge's Firm Has Been Engineer

The firm has been engineer for some of the largest bridges and buildings in the country, among others being the Duluth & Superior Bridge, the cantilevers across the Monongahela and Ohio rivers at Pittsburgh and Steubenville for the Wabash Railway, the Municipal Bridge across the Mississippi River for the city of St. Louis, the bridges across the Connecticut River at Hartford, Saybrook and East Haddam for the state of Connecticut; the Singer tower, the Metropolitan tower and many other large structures. The Central Bridge, Melrose Avenue Viaduct, Riverside Drive Viaduct at 96th Street and the proposed steel arch to cross Spuyten Duyvil Creek on the proposed extension of Riverside Drive are among the structures designed by Mr. Hodge's firm for New York City. It has also been retained by the United States government, by several states and many cities, and is engineer for all structures on the National Lines of Mexico as well as for bridges in Hayti, Peru, Bolivia, Brazil and other foreign countries.

Mr. Hodge served as a commissioner appointed by the State of New York to pass upon the original design of the Blackwells Island Bridge in New York City, and, later, was again appointed to make a report on the carrying capacity of the structure. He was also appointed a commissioner to pass upon the original design of the Manhattan Bridge. He served the Canadian government as consulting engineer on the new design for the Quebec Bridge. At present he is consulting engineer to the New York and New Jersey Interstate Bridge & Tunnel Commission on the proposed 3000-ft. suspension bridge across the North River at Fifty-seventh Street.

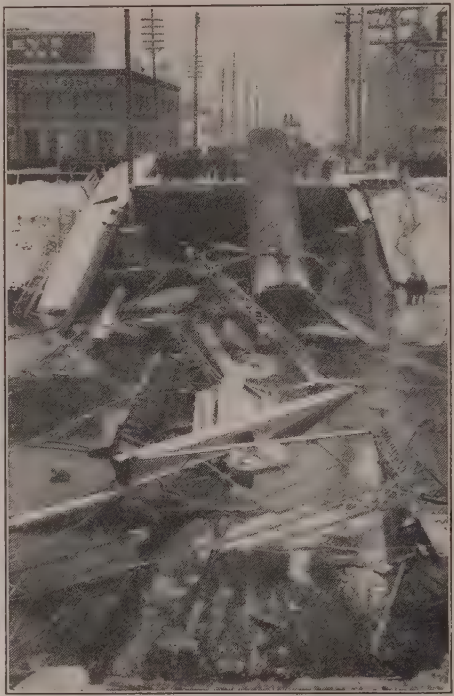
He is a member of the council of the American Institute of Consulting Engineers, a director of the American Society of Civil Engineers, a member of the Institute of Civil Engineers of Great Britain, the Canadian Society of Civil Engineers and the Railroad Club.

Second Annual Arizona Irrigation Congress to be Held Jan. 15

The second annual Arizona Irrigation Congress will be held at the University of Arizona, Jan. 15.

H. E. Cleland Joins McGraw Publishing Company's Staff

It is a pleasure for the McGraw Publishing Company to announce that H. E. Cleland will join its staff Jan. 10. Mr. Cleland's long experience, proven ability and brilliant service as advertising manager and manager of the Service Department of the Hill Publishing Company are well known and fully appreciated by advertisers in the engineering field. His acquisition is further evidence of the McGraw Publishing Company's desire to give to advertisers in the Engineering Record and the three other papers it controls the most efficient service which it is possible to render.



GENERAL WRECKAGE OF SPOKANE BRIDGE FAILURE

Two trolley cars fell with the bridge; one, however, is still supported by the end abutment. Six lives were crushed out by the falling upper chord striking the car seen with seats exposed in the center of the picture.

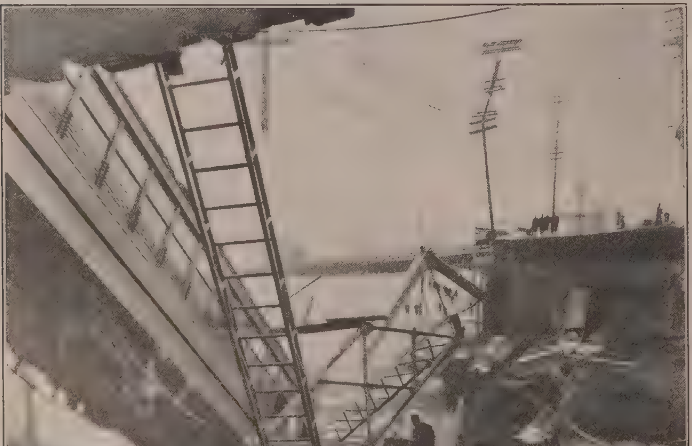
Memphis Bridge Falsework for Fixed Span Still Holds

Although two more bents of the falsework between piers 3 and 4 and one bent of the fixed span falsework of the Harahan Bridge over the Mississippi River went out on Dec. 29, following the fourteen bents which were washed out on Dec. 23 and one on Dec. 25, at last reports the adjacent fixed span was still safe and the balance of its falsework in place. The pictures on the opposite page show the bridge before and after the failure which resulted not only in the loss of over 100 of the track stringers being used temporarily for the traveler runway and some lower chord members, but also the traveler, four donkey engines and other erection equipment.

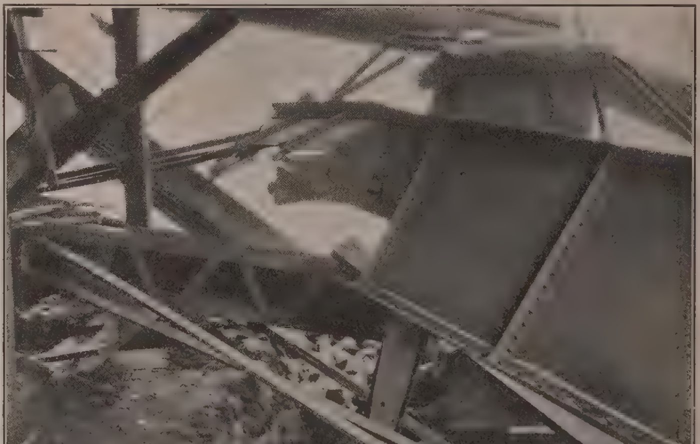
The pile bents each contained thirty-two piles ranging from 84 to 91 ft. in length, upon which the 12 x 12-in. timber legs of the falsework rested, the height being about 65 ft. A total number of nineteen bents were in place in the 604 ft. between piers 3 and 4, and on Dec. 29 only two bents were still standing. This falsework was to carry the travelers and the semi-suspended span on the west or Arkansas end.

The bridge, which is a cantilever structure, was described in Engineering Record of Nov. 8, 1913, page 516. Owing to unprecedented high water during the summer, erection of the 621-ft. fixed span and the west span could not be begun until the middle of September. In order to complete the work without unnecessary delay it was therefore necessary to use falsework in both openings. The excessive rise in the Mississippi the latter part of December resulted in a river stage of 28.2 ft. on Dec. 24, 32.2 ft. on Dec. 29, and 34.6 ft. on Jan. 4. A great amount of driftwood accumulated behind the falsework. The entire bridge had been erected except the two 186-ft. cantilever arms, the 418-ft. semi-suspended span and one-half of the 418-ft. suspended span.

This bridge is being fabricated and erected by the Pennsylvania Steel Company of Steelton, Pa., for the Arkansas and Memphis Railway Bridge and Terminal Company. Ralph Modjeski of Modjeski and Angier, Chicago, is the designing engineer. Thomas Earle, vice-president of the Pennsylvania Steel Company, kindly furnished the photographs with the above information, through the courtesy of Mr. Modjeski.



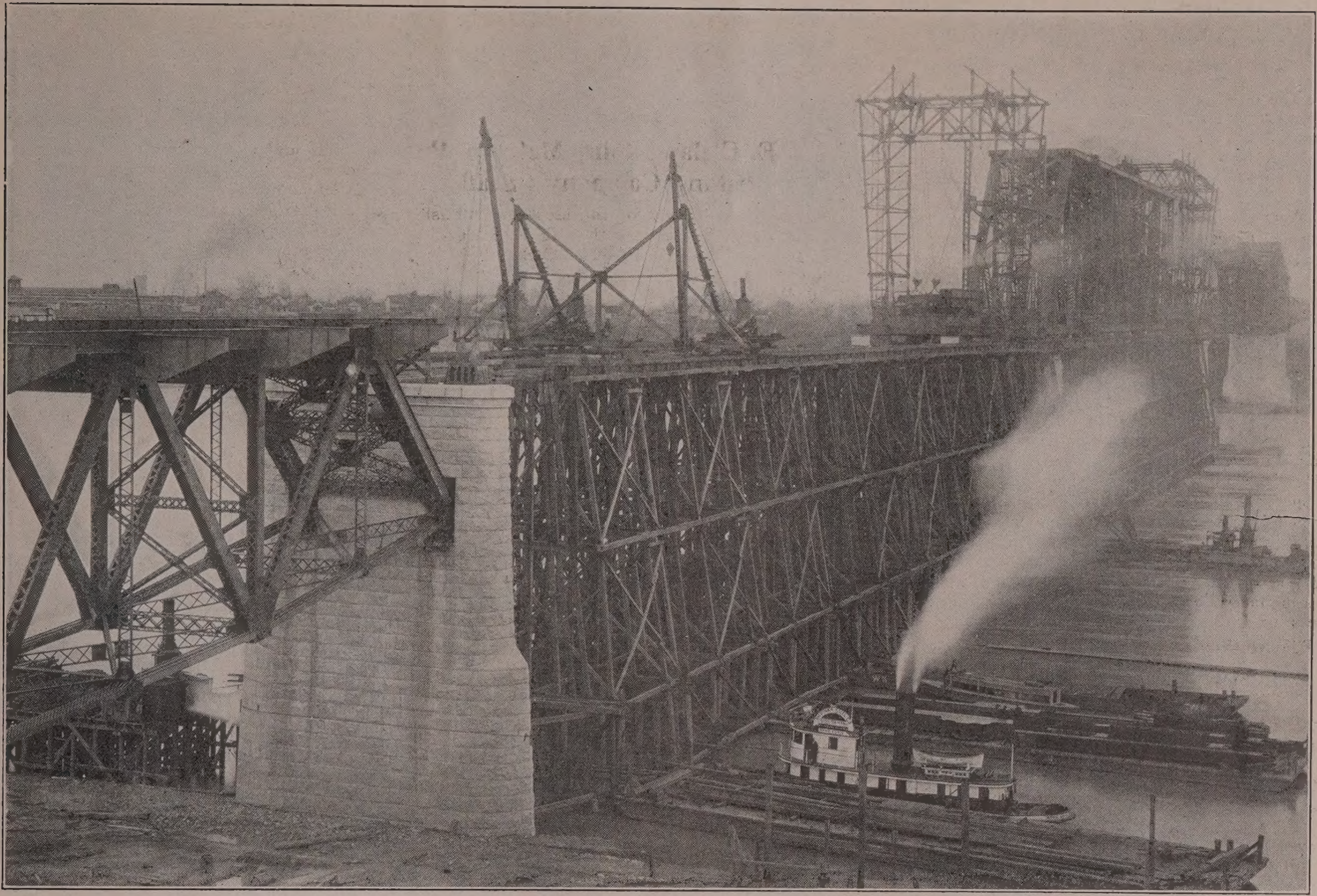
WRECK OF DIVISION STREET BRIDGE IN SPOKANE, WASHINGTON



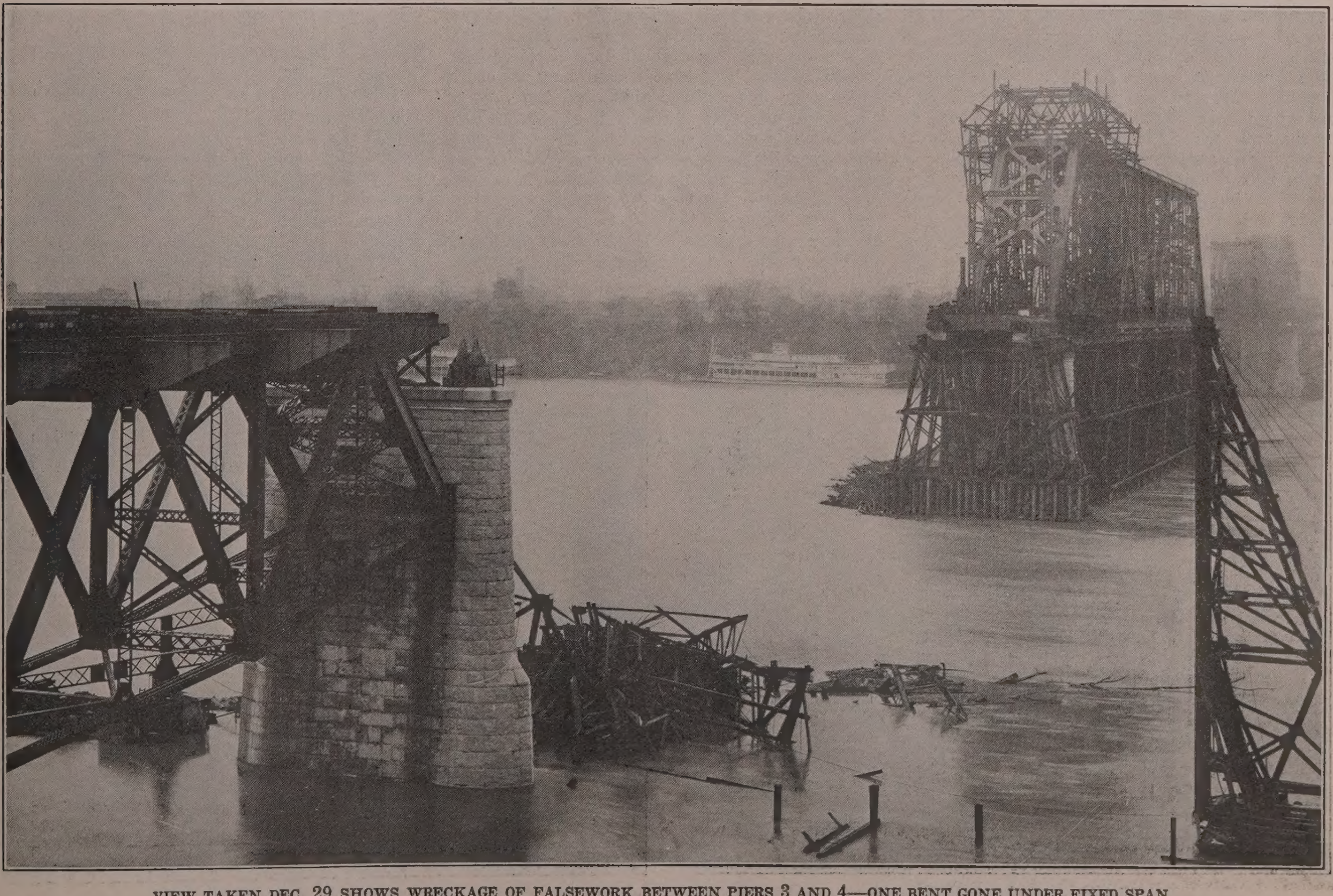
BROKEN LOWER CHORD EYEBARS THAT CAUSED THE FAILURE

Description of this bridge failure is given in last week's issue of the Engineering Record, page 29, and in the editorial in this issue on page 35.

Memphis Bridge Before and After Accident



VIEW OF FALSEWORK BETWEEN PIERS 3 AND 4 TAKEN FROM THE WEST SHORE DEC. 19 SHOWS ERECTION EQUIPMENT



VIEW TAKEN DEC. 29 SHOWS WRECKAGE OF FALSEWORK BETWEEN PIERS 3 AND 4—ONE BENT GONE UNDER FIXED SPAN

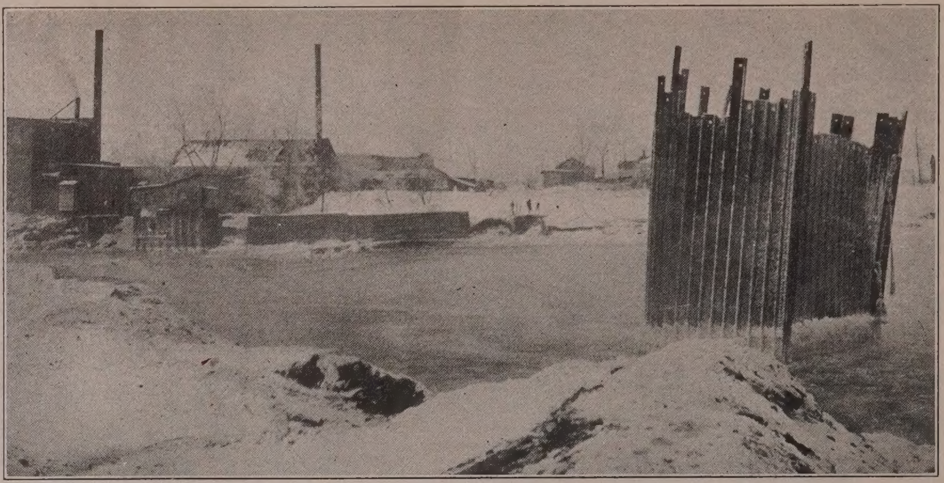
Ninety-Year-Old Dam Removed on Completion of New Structure

(*Continued from Page* 61, *First Column*)

The new concrete dam, which is of solid section, runs from a series of headgates on the west bank to a navigation lock on the east bank. The headgates will be leased to the highest bidder for the purpose of utilizing them for a hydroelectric power plant. The lock is the same width, 45 ft., as those of the Barge Canal, but is about 520 ft. long between its upper and lower mitering steel gates. About one-half of the spillway is constructed on a considerable skew with the river, and runs for some 600 ft. from the headgates, opposite the lower guide wall, to a point opposite the middle of the lock. Its crest is about 4 ft. above that of the old dam. It was built complete in a large wooden cofferdam during the season of 1914. The second section of the dam, which is also about 600 ft. in length, extends from the north end of the first spillway straight across the river to the lock, and has a crest 2 ft. lower than that of the first spillway. It also was built in a single cofferdam of steel sheet piling, and was completed in the season just closed. This coffer was made by driving isolated circular pockets or anchor cylinders, part up-stream and part down-stream from the site of the dam.

Original Plan for New Dam Modified

The original plan contemplated ten of these cylinders, spaced from about 30 ft. to about 130 ft. clear distance, but owing to the constantly-recurring high water their locations had to be modified somewhat. Between each of these pockets was set up on the river bed, without being driven, a single line of steel piling, held together by the interlocks of the piles, and depending on the mass of the banking for stability. The cofferdam was therefore heavily banked inside with dredged material, and a bank sloping down from the water line was placed outside to increase the watertightness. The deepest excavation close enough to the coffer banking to produce an effective head equal to its depth was about 33 ft. below the upstream pool level, and the deepest water in which any portion of the cofferdam was built was about 28 ft. Each of the two sections of the main dam was built in a single season, little trouble being experienced with floods during the first season, but much during the second season. The lock which contains about 45,000 cu. yds. of concrete, as compared with 22,000 cu. yds. for the dam and headgates, was under construction for two years, counting from the time of commencing work upon its cofferdam, and the latter had to be flooded a number of times. The walls of the lock are about 10 ft. higher than the low crest of the dam. Although the maximum flood stage expected, about 30 ft. above low water, will submerge them, navigation will not have to be suspended except for short periods, as extreme high water during the season of traffic is very rare.



FIRST BREAK IN DIKE, CORNERS OF WHICH WERE PROTECTED WITH SHEET PILING

Old Dam Timber Crib Structure

The old dam was a timber crib structure filled with stone and having timber decks which sloped down and up stream. Its abutment on the west end was also of stone and timber, and rested upon the shale rock. The old lock on the east bank, also built upon rock, was of ashlar masonry with timber guide walls and gates. The structure had been patched repeatedly, and the lock itself now contains some concrete. The first half of the 1000-ft. dam was removed chiefly by derrick boats with orangepeel buckets behind the protection of the earth dike referred to. During the removal two other dams were uncovered, with their crests immediately below that of the present dam. The lowest dam had its crest some 2 or 3 ft. above tide, and the second dam had its crest about 4 ft. higher. The timbers of both of these dams were fastened together with hardwood pins, and some of the sticks were 18 in. square. Remains of old breaks, such as masses of displaced sheathing and cribs lying on their sides in the body of the dam, also came to light. The east half will also be dredged out behind earth dikes of much less height.

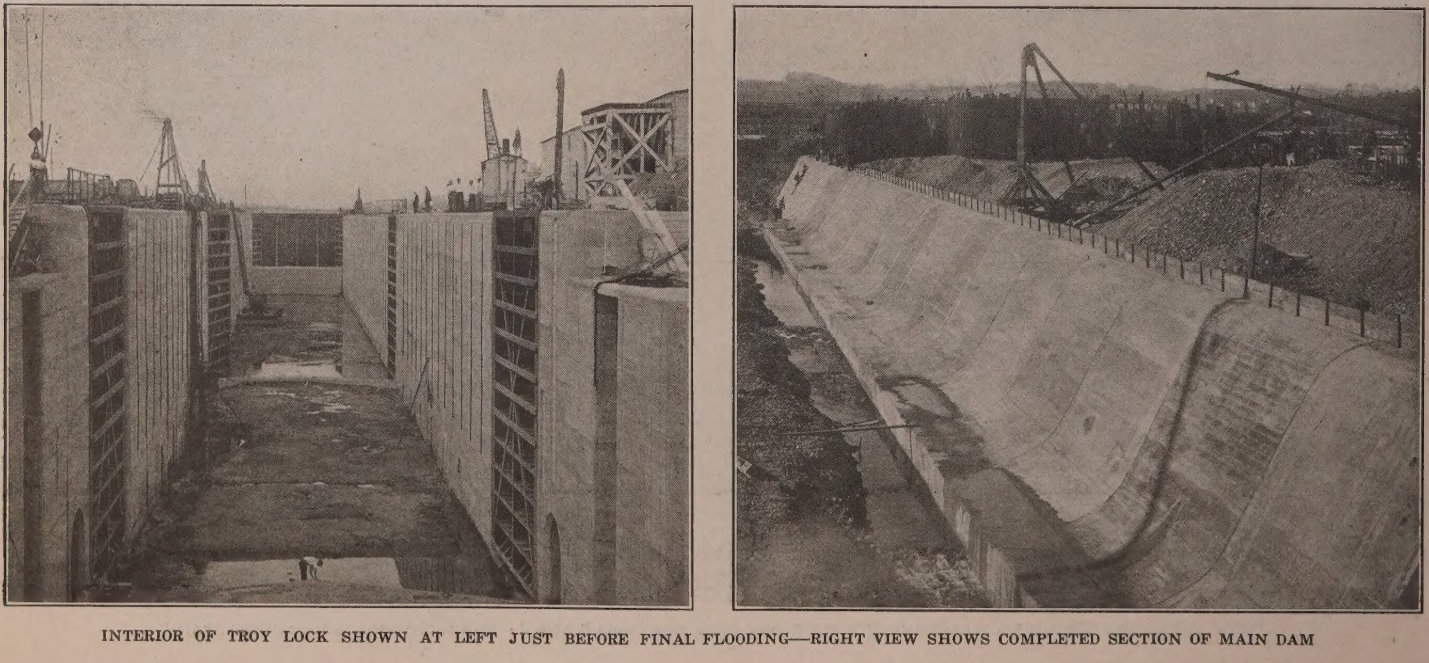
The Troy lock and dam has been built under the direction of the Corps of Engineers, U. S. A., Col. William M. Black being in general charge of the district. All the work was carried out by Government forces under the local direction of Major M. J. McDonough, Corps of Engineers, with D. A. Watt as principal assistant engineer and J. J. McCabe junior engineer in charge of Troy.

Photos of City College Stadium

In the article describing the new concrete stadium for the College of the City of New York, published in last week's issue, credit should have been given to the American Architect for the copyrighted photographs of the structure. The fact that the pictures which the Engineering Record received lacked the usual copyright mark and carried no other information which indicated that acknowledgement of their source was due was responsible for this omission.

Time Extended for Liability Insurance Premium Payments

The State Insurance Fund Board has extended the time for payment of premiums for liability insurance in the state fund until Jan. 15. Hundreds of contractors throughout the state have taken out insurance in the fund to protect themselves under the workmen's compensation act. Many of the contractors however, continue to take out insurance in the old line companies.

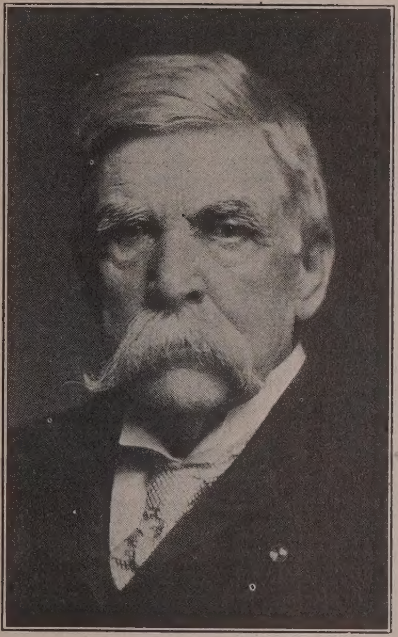


INTERIOR OF TROY LOCK SHOWN AT LEFT JUST BEFORE FINAL FLOODING—RIGHT VIEW SHOWS COMPLETED SECTION OF MAIN DAM

Grenville Mellen Dodge Dead

General Grenville Mellen Dodge, builder of the Union Pacific Railroad and honorary member of the American Society of Civil Engineers, died at Council Bluffs, Iowa, Jan. 3. He was born at Danvers, Mass., in 1831 and was educated at Captain Partridge's Military Academy and Norwich University in Vermont, receiving the degree of civil engineer from the latter in 1850. His first engineering service was with the Illinois Central Railroad, the Rock Island lines and on the survey for the Union Pacific. He served through the Civil War as colonel of volunteers, brigadier-general and major-general successively, being promoted on each occasion for distinguished service. While in command of the District of the Mississippi he built the Mississippi & Ohio Railroad.

Railroad Builder and Last Surviving Civil War Corps Commander Dies



GENERAL GRENVILLE MELLEN DODGE

After the war he was appointed chief engineer of the Union Pacific Railroad, then in the course of construction. In this work he was frequently hampered by attacks of hostile Indians.

In 1870 he became chief engineer of the Texas & Pacific, in which office he remained ten years. Later he was retained as consulting engineer on the St. Gothard tunnel and the planning of the Black Forest Railway in Europe. He was elected an honorary member of the American Society of Civil Engineers in the early part of last year.

New Business Manager of Engineering Record Appointed

L. W. Seeligsberg has been appointed business manager of the Engineering Record, succeeding A. B. Gilbert, who will devote his time to the circulation and searchlight departments. Mr. Seeligsberg is a graduate of Stevens Institute of Technology where he received his degree in mechanical engineering in 1896. For a number of years he has directed the work of the copy service department of the McGraw publications and for a year was the Engineering Record's advertising representative in charge of the Philadelphia territory. His long and well-rounded experience in sales promotion and publicity work in the engineering field makes him particularly well fitted for his new duties.

Urge Schoharie Addition to Catskill Water Supply

Merchants' Association of New York Recommends Immediate Action on Project for 250,000,000 Gallons Daily

Basing its action upon a report by Henry R. Towne of the Yale & Towne Manufacturing Company, chairman of its committee on water supply, the Merchants' Association of New York on Jan. 4 adopted resolutions in favor of the immediate extension of the Catskill water supply system to the Schoharie watershed. Thus far the Board of Water Supply has directed the efforts to the development of the Esopus watershed, where the great Ashokan reservoir is located. From this source the estimated daily yield is 250,000,000 gal. and the works for delivering this amount to New York, including dams, aqueducts, pipe lines and connections to the existing distribution system, are practically completed and ready for the "tuning-up" process prior to the placing of the system in regular service.

The Catskill project, however, contemplated a daily supply of 500,000,000 gal., and of this amount the Schoharie project, with a drainage area of 228 sq. miles was counted upon to yield about 250,000,000 gal., at a cost of $22,000,000; the estimated time required for its completion is 8 years. The Schoharie works involve a large dam and reservoir at Prattsville and a 10-mile tunnel connection with the Ashokan reservoir.

The Merchants' Association report bases its plea for the immediate construction of the Schoharie unit of the Catskill project upon the following statistics of water consumption and available supply: The present safe delivery from all existing sources is 550,000,000 gal. daily, the population in 1915 being estimated at 5,200,000. With 250,000,000 gal. added from the first installment of the Catskill supply a total of 800,000,000 gal. daily would be available, but of this quantity, according to the report, only the yields of the Croton and Catskill watersheds, aggregating 550,000,000 gal., should be considered. This would eliminate the present yields from municipal and private works in all of the city boroughs except Manhattan. To make up this deficiency, the report states, the 250,000,000 gal. daily from the Schoharie shed is imperative to meet the consumption of 800,000,000 gal. daily in the year 1921.

The report characterizes as illogical the suggestion that the new Catskill work be taken from the Board of Water Supply and turned over to the Department of Water Supply, Gas and Electricity. Mr. Towne says in conclusion:

"Viewed from every side and from every angle, the question at issue appears to admit of but one satisfactory solution, namely, that the city should now authorize the planning and undertaking of the work needed to utilize the Schoharie watershed as an additional source of supply, and, before this becomes available, should also undertake the work of completing the Catskill aqueduct to make available its full capacity of 500,000,000 gal. daily, and should intrust the execution of the work thus implied to the present Board of Water Supply, created expressly for this purpose. Its honorable, efficient and honest administration in the past, under which the city has wisely and safely invested the great sum of $160,000,000, constitutes the best possible guaranty that like conditions of skillful planning, efficient execution and honest management will prevail until the last unit of the great work has been completed. Then, and not until then, should the operation and upkeep of the great system be transferred from its builders to the care of the proper city department."

The Board of Estimate and Apportionment will hold a hearing on the Schoharie proposal Jan. 18.

Greater Caution Shown in Avoiding Overproduction of Cement

An estimate of Portland cement produced in the United States in 1915, just made by Ernest F. Burchard of the United States Geological Survey, indicates that the shipments from the mills amounted to 86,524,500 barrels, as compared with 86,437,956 barrels in 1914, and that the production was about 85,732,000 barrels, as compared with 88,230,170 barrels in 1914.

The stocks of finished cement at the mills were about 11,583,000 barrels, as compared with 12,893,863 barrels in 1914. The slight decrease in production and the considerable decrease in stock is thought to indicate greater caution in the industry, which in the preceding few years showed a tendency toward overproduction.

Storm Does Heavy Damage to Wires in Pennsylvania

The sleet and ice storm of Dec. 29 and 30 did heavy damage to electric wires and poles in Pennsylvania. The property of the Bell Telephone Company and the Western Union Telegraph Company suffered considerably, poles going down under the great weight of the ice frozen on the wires for hundreds of rods at a stretch. Harrisburg suffered more than most cities in the East from wire trouble.

All poles on the north side of the Pennsylvania Railroad yards at Enola were broken off and the trunk lines of the Bell Company and the Western Union to the West were thrown out of service.

POLES DOWN FOR NEARLY A MILE AT A STRETCH NEAR SHIREMANSTOWN, PA.

Smith, Hauser & Mac Isaac Organize Underpinning Department

With practically all of its difficult underpinning and foundation work on the William Street section of New York's new subway system completed the firm of Smith, Hauser & Mac Isaac, Inc., of New York City, has decided to capitalize its experience in this field by maintaining its present underpinning organization as a special permanent department of the company, which is now prepared to undertake contracts for subsurface work in any part of the country. The William Street subway extends through the heart of the city's financial district and is flanked by skyscrapers representing many millions in property values. These conditions necessitated unusual care in the underpinning operations, and special methods were developed for safely transferring the building loads from old to new foundations, the latter involving the use of steel-jacketed concrete piles, the casings of which were put down in 1 or 2-ft. sections. Among the buildings which had to be supported alongside of the subway excavation were the New York Cotton Exchange, the National City Bank, the Kuhn-Loeb Building, the Bank of New York and the Bank of America.

The unusual extent of the underpinning work in connection with the subway construction called for a large force of highly trained specialists and these men, now that the William Street work is nearly finished, will form the nucleus of Smith, Hauser & Mac Isaac's newly created underpinning and foundation department. In its future operations the department will have the benefit of general supervision by Lazarus White, the firm's managing engineer, who several years ago was division engineer in charge of the Rondout siphon tunnel and the city tunnel of the Catskill aqueduct, and F. J. Mac Isaac, member of the firm.

Personal Notes

H. J. Hanmer has been reappointed city engineer of Gloversville, N. Y.

J. L. Piper, resident engineer for the California Highway Commission, has completed the supervision of contracts of 7½ miles of concrete highway between Folsom and White Rock in Sacramento County and has been transferred to Placer County to have charge of the construction of ten miles of concrete highway between Lincoln and Wheatland.

Julius Adler has been appointed engineer of tests of the Bureau of Surveys, Department of Public Works of Philadelphia. He was graduated from the University of Pennsylvania in 1908, and served there as instructor in civil engineering until 1909, when he was appointed instructor in charge of the highway engineering course at the University of Washington. He entered the employ of the city of Philadelphia in 1912, and was appointed assistant engineer in charge of material inspection and the inspection of asphalt paving plants, creosoting plants and bituminous road materials plants in 1913. During the summers of 1908 and 1909 he was with the U. S. Office of Public Roads as civil engineer student, engaged in laboratory tests of highway materials and field work on construction and, during the summers of 1910 and 1911, he served in the office of the city engineer of Seattle, Wash., on similar work and on the field investigation of local concrete materials for the Cedar River dam.

Harold O. Hicks, formerly transitman in the track department of the Cleveland Railway Company, has been appointed engineer in the division engineer's office of the Public Service Railway at Camden, N. J.

Carleton E. Davis has been reappointed chief of the Bureau of Water, Philadelphia, by Mayor-elect Smith of that city. Mr. Davis was graduated from Massachusetts Institute of Technology in 1893 and was engaged continuously in water supply and water power work in the New England States until 1900, when he was appointed resident engineer in charge of surveys, plans and construction of the Cedar Grove Reservoir, 8 miles of 60-in. riveted steel pipe line and 3000 ft. of pressure tunnel for the Board of Water Commissioners of Newark, N. J. From 1904 to 1905 he was engineer of the waterworks and sewers for the Isthmian Canal Comission at Panama and, from the latter year until 1912, he served as engineer in charge of the reservoir department of the Board of Water Supply of New York City on the Catskill aqueduct work. He has been chief of the Philadelphia water bureau for about 3½ years.

John G. Rose, formerly with the Consolidation Coal Company on the development of its properties in the Elkhorn region in eastern Kentucky, has associated himself with the Kennicott Company of Chicago Heights, Ill. Previous to his work with the Consolidation Coal Company, with which he was connected for about three years, Mr. Rose was engaged as civil, hydraulic and irrigation engineer at Denver, Col. In his new connection he will be engaged in the design and manufacture of water softening and pressure filter plants.

Walter M. Squires has resigned his position as deputy city smoke inspector of Cincinnati to become superintendent of the smoke abatement league of that city.

Charles M. Spofford, consulting engineer, of Boston, and professor of civil engineering at the Massachusetts Institute of Technology, has been requested by Edward F. McSweeney, chairman of the Directors of the Port of Boston, to act with Guy C. Emerson, consulting engineer of the Boston Finance Commission, and F. W. Hodgdon, engineer for the board, as consulting engineers on the new drydock being constructed in that city.

J. W. Shields has been reappointed city engineer of Altoona, Pa.

Alfred H. Hartman, division engineer of the Baltimore Sewerage Commission, will carry to completion the work of the combined storm-water, low-level and high-level sanitary divisions. Mr. Hartman has been connected with the Baltimore work since 1906, first as designing engineer, and, for the past six years, as division engineer. The storm-water drainage system, Jones Falls improvement, sewage pumping station, Forest Park sewage disposal plant and the low-level sanitary sewerage system were constructed under his immediate direction as division engineer.

J. F. Poland and R. E. Miller have organized the Poland-Miller Company, Erie Building, Cleveland, to conduct a general engineering business, specializing in the design and inspection of coal, coke and ore handling machinery, docks and industrial plants. Mr. Poland was formerly associated with the Brown Hoisting Machinery Company and the J. W. Frazier Company as civil and structural engineer. Mr. Miller was formerly connected with the latter company as mechanical and electrical engineer.

John B. Dickson, general superintendent of the Erie Railroad at Cleveland, has been appointed general manager of the lines west, with office in the same city. Mr. Dickson entered railway service in 1881 on the Pennsylvania, where he remained until 1893, attaining the grade of supervisor in 1897. From this service he went to the Chicago & Northwestern for a period of nine years. In 1902 he was appointed assistant engineer maintenance-of-way for the Baltimore & Ohio, and, in 1905, he became chief engineer maintenance-of-way. He became connected with the Erie in 1907 as division superintendent at Rochester.

D. W. Chamberlain, formerly division engineer for the California State Highway Commission at Fresno, has been appointed county highway engineer of El Paso County, Texas.

Edgar S. Closson has been reappointed town engineer of Montclair, N. J.

Aetna Engineering Bureau, civil and sanitary engineers, 17 North La Salle Street, Chicago, will hereafter conduct business under the firm name of Marr, Green & Company, civil and sanitary engineers, with offices at the same address.

E. E. Harper, consulting engineer, of Kansas City, Mo., specializing in water supplies, water purification and power plants, has moved his offices from Grand Avenue Temple to 2404 East Thirtieth Street, Kansas City.

Arthur LaRoche, formerly city engineer of Binghamton, N. Y., has been appointed deputy city engineer. Mr. LaRoche was graduated from Union College in 1908. The appointment gives him practically the same office as he formerly held, except for an increase in salary. The change in title is due to the change of Binghamton from a third to a second class city.

O. E. Bulkeley, assistant superintendent and engineer of the water department of Rockford, Ill., has been made superintendent of the water department at Jackson, Mich., under Gaylord Cummin, city manager.

George W. Townsend has resigned from the office of assistant engineer with the Sewerage Commission of Baltimore.

C. C. Kidd, formerly connected with the valuation department of the Chicago & Eastern Illinois Railroad, has been appointed designing draftsman in the bridge department of the Baltimore & Ohio at Baltimore.

Robert S. Parsons, formerly general manager of the Erie Railroad, lines west, has been appointed chief engineer and assistant to the president. He was graduated from Rutgers College in 1895 and entered railway service on the Erie that year as transitman in the New York division. In 1903 he was appointed engineer of maintenance-of-way of the lines east of Buffalo and Salamanca and the following year engineer maintenance-of-way of the lines west. He became superintendent of the New York division in 1907, and attained the grade of general manager in 1914.

Obituary Notes

Ole N. Trooien, who served as an engineer on the construction of the Pennsylvania Railroad Tunnels under the Hudson River, New York City, died at Brookings, S. D., Dec. 21, 1915.

George V. Sneden, engineer maintenance-of-way of the New York & Long Branch Railroad, died in Long Branch, N. J., Dec. 24, 1915.

Thomas J. Ivey, one of the leading contractors of Johnstown, Pa., died Dec. 30, 1915, of typhoid fever. He was 44 years of age.

Marseillus N. Nurse, who for sixteen years served as engineer of the Department of Public Works of California, died at his home in Sacramento, Dec. 28, at the age of sixty-nine. Mr. Nurse was at one time civil engineer of the Clear Lake Water Company of San Francisco, and is said to have been the original promoter of the project to conserve the water of Clear Lake for power and irrigation purposes. Later he became identified with various reclamation enterprises in the Sacramento Valley. He was also a member of the Dabney commission of engineers for formulating a plan of flood control for the State.